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OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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The professional papers contained in The Journal are published prior to the meetings at which they are to be presented, in order to afford members an opportunity to prepare any discussion which they may wish to present.

The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions. C55

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COMING MEETINGS

MEETING IN ST. LOUIS, JANUARY 14

The monthly meeting of the Society in St. Louis, which was called for Saturday evening, December 10, in the Engineers Club of St. Louis, has been postponed on account of the sudden death of William H. Bryan, Chairman of the Committee on Meetings of the Society in St. Louis. It will be held instead on January 14, when the paper on Modern Shoe Manufacture by M. B. Kaven and J. B. Hadaway, and that on Operating Conditions of Passenger Elevators by R. P. Bolton, will be considered.

JANUARY MEETING OF THE SOCIETY IN BOSTON

The January meeting of the Society in Boston will take the form of a dinner given by the three societies, the Boston Section of the American Institution of Electrical Engineers taking charge, and the Boston Society of Civil Engineers and The American Society of Mechanical Engineers coöperating. The occasion will be similar in its nature to the one given last year in honor of President Westinghouse and a number of prominent people are expected to be present and to address the gathering. The exact date has not yet been definitely announced.

MEETING IN NEW YORK, JANUARY 10

The monthly meeting for January will be held in the Engineering Societies Building on Tuesday evening, the tenth. The paper will

be on the Mechanical Handling of Freight, by S. B. Fowler, consulting engineer, Boston, Mass. This is the paper which was presented at the meeting in Boston in December and brought out an extended discussion. The question of terminal facilities and freight handling is so important a one in New York and the interests of railroads and shippers alike are so great that there should also be a thorough discussion at the New York meeting.

REPORTS OF MEETINGS

MEETING IN BOSTON, DECEMBER 16

A meeting of the Society in Boston was held on December 16, with the coöperation of the Boston Society of Civil Engineers and of the Boston Section of the American Institute of Electrical Engineers, the attendance being about 60. After the transaction of business Samuel B. Fowler, Mem.Am.Soc.M.E., presented his paper on the Mechanical Handling of Freight, and the various phases of the situation were discussed by D. B. Rushmore, Mem.Am.Soc.M.E., of the General Electric Company, Schenectady, N. Y.; C. W. E. Clarke, Assoc.Am.Soc.M.E., of the Stone and Webster Company, Boston; Ernest W. Day, Engineer for the Hood Rubber Company, Boston; F. W. Hodgden, Engineer of the Harbor and Land Commission; R. H. Rogers, of the Power and Mining Engineering Department, General Electric Company, Schenectady, N. Y.; R. E. Curtis, Mem. Am.Soc.M.E., Edison Electric Illuminating Company, of Boston; George H. Eaton, General Freight Agent of the Boston and Maine Railroad Company; and G. T. Sampson, Division Engineer of the New York, New Haven and Hartford Railroad Company. The whole subject aroused much interest on the part of those present.

MEETING IN SAN FRANCISCO, DECEMBER 16

As an outcome of plans made at the organization meeting of the members of the Society resident in San Francisco and vicinity on October 14, the first meeting for the discussion of professional topics was held in that city on December 16. Pacific Coast Practice in the Use of Crude Petroleum as Fuel was made the subject of a topical discussion, with the following brief papers: Present and Future Supply of Petroleum as Fuel on the Pacific Coast, by Arthur F. L. Bell, with the Associated Oil Company, San Francisco; Relative

Heating Value of Light Oil as Compared with Heavy Oil, by Prof. J. N. LeConte, Mem.Am.Soc.M.E., of the University of California, Berkeley; Comparison of Evaporative Value of Oil and Coal, by C. F. Wieland, Mem.Am.Soc.M.E., Consulting Engineer, San Francisco; Furnace Arrangements for Using Oil as Fuel under Boilers, including the Subject of Air Requisite for Proper Combustion, by C. R. Weymouth, Mem.Am.Soc.M.E., Mechanical Engineer in charge of the Engineering Department of Chas. C. Moore and Company, San Francisco; Practice as to Size of Stacks with Oil Fuel, K. G. Dunn, Assoc.Am.Soc.M.E., Vice-President of Hunt, Mirk and Company, Inc., San Francisco; Marine Use of Fuel Oil, by J. H. Hopps, Mem. Am.Soc.M.E., Consulting Engineer, San Francisco; Locomotive Practice in the Use of Fuel Oil, by Howard Stillman, Mem.Am.Soc. M.E., Mechanical Engineer and Engineer of Tests with the Southern Pacific Company, San Francisco; Atomization of Oil Fuel, including the subject of When and Where the Use of Compressed Air is Justified or Required, by A. M. Hunt, Mem.Am.Soc.M.E., Consulting Engineer, San Francisco; Present Status of the Manufacture of Producer Gas from Crude Oil, by E. C. Jones, Chief Engineer of the Gas Department, California Gas and Electric Corporation and San Francisco Gas and Electric Company, San Francisco.

After the reading of these papers, the meeting was thrown open and a very general discussion of the subject followed.

STUDENT BRANCHES

At the regular meeting of the Columbia Student Branch on December 2, F. B. Whittemore delivered a lecture on the Daimler Valveless Gas Engine.

Prof. H. E. Hibbard, Mem.Am.Soc.M.E., gave an account of the November meeting of the Society in St. Louis, at the meeting of the Missouri University Student Branch on November 22.

The Pennsylvania State College Student Branch held a meeting on November 17 at which a paper on the Utilization of Blast Furnace Waste Products was read by T. C. McConnell (1911), which was chiefly concerned with the uses of furnace gas as a fuel.

On December 17 the Polytechnic Institute Student Branch enjoyed an address by S. B. Redfield, Mem.Am.Soc.M.E., on Compressed Air. At the January meeting F. R. Low, Mem.Am.Soc.M.E., will address the members.

The Purdue Student Branch was addressed at its meeting of November 30, by C. Luhn, who spoke upon the New Cincinnati Water

Works. Prof. A. W. Cole, Mem.Am.Soc.M.E., was the speaker on December 14 and, with the topic of the Development of Steam Navigation, gave a brief historical sketch of the progress of the art since the time of the early Egyptians.

A new student branch has been formed at Rensselaer Polytechnic Institute with 18 members. At a business meeting on November 9 Prof. A. M. Greene, Jr., was elected Honorary Chairman and Harrison Weaver Secretary. At the conclusion of the business Professor Greene delivered an address on Steam Pumping Machinery which was illustrated with lantern slides.

J. B. Bubb, president of the Stanford Mechanical Engineering Society, presented a paper at the November 16 meeting on The Saw-Tooth Skylight.

On December 2 the Stevens Engineering Society considered the subject of Locomotives, with a paper by George W. Armstrong (1911), on the Mallet Compound Locomotive, illustrated by a reflectoscope. This was very fully discussed by others who were present.

The University of Wisconsin Student Branch held a meeting on December 8, at which J. Langwill gave a talk upon Special Drilling Machinery and E. Week spoke about the Cyanide Process of Extracting Gold. Prof. Kinne followed with an illustrated address upon Bridge Deflection with special attention to the work done along this line under the direction of the Dean of the College of Engineering, with the purpose of determining the effect of impact.

The Yale Mechanical Engineers Club entertained at its meeting on December 6, J. W. Lieb, Jr., of the New York Edison Company, Mem.Am.Soc.M.E., who gave an illustrated lecture on the different considerations in Power Plant Design with specific examples of several modern high-efficiency plants.

At a meeting of the University of Cincinnati Student Branch on November 18, J. D. Lyon of the Westinghouse Company presented a paper on Gas Engines and Producers, supplementing his remarks with lantern slides.

The University of Maine Student Branch has elected the following officers for the current year: A. H. Blaisdell, president; W. B. Emerson, secretary; C. E. Sullivan, vice-president; G. B. Chapman, treasurer. At a meeting on December 8, a paper on Rail-bond Testing for Electric Railways was presented by A. T. Childs, Assoc.A.I.E.E. The paper was well illustrated with lantern slides and was an excellent example of the use of automatic apparatus for the rapid collection of engineering data.

JOHN FRITZ MEDAL AWARD

The John Fritz Medal, established by the professional associates and friends of John Fritz, Hon. Mem.Am.Soc.M.E., of Bethlehem, Pa., in perpetuation of the memory of his achievements in industrial progress, and which is annually awarded by a Board made up of four representatives from each of the national engineering societies, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, and The American Society of Mechanical Engineers, was formally bestowed, November 30, 1910, on Alfred Noble, Mem.Am.Soc.M.E., for notable achievements as a civil engineer. The Medal has been previously awarded to Lord Kelvin (1905) for his work in cable telegraphy and other scientific attainments; to George Westinghouse (1906) for the invention and development of the air brake; to Alexander Graham Bell (1907) for the invention and introduction of the telephone; to Thomas Alva Edison (1908) for the invention of the duplex and quadruplex telegraph, the phonograph, the development of a commercially practical incandescent lamp, and the development of a complete system of electric lighting; and to Charles T. Porter (1909) for his work in advancing the knowledge of steam engineering and in improvements in engineering construction.

The meeting, which was held at the house of the American Society of Civil Engineers, was called to order by Prof. Samuel Sheldon, Past-President Am.Soc.C.E., who stated briefly the significance of the medal and introduced Mr. Isham Randolph. Mr. Randolph spoke of the history of civil engineering and was followed by Dr. Rossiter W. Raymond, Secretary of the American Institute of Mining Engineers, who read a very happy biographical sketch of Mr. Noble's career from his early days on a Michigan farm down to the completion of the Pennsylvania Railroad Company. He was followed by Mr. Noble himself, than whom, to quote Dr. Raymond, few men have done more interesting and important work with greater aversion to talking about it. Mr. Noble said in substance that he was confident that the award of the Medal to him was made to the profession, of which he felt doubly honored to be ranked as the representative, rather than to himself as an individual. The civil engineer, he said, did not invent so much as prevent, and very little of his work was of any interest to the public.

At the close of the proceedings an informal reception was held in the main assembly room.

THE ANNUAL MEETING

The thirty-first Annual Meeting of The American Society of Mechanical Engineers was held in the Engineering Societies Building December 6–9, 1910, with an attendance of 633 members and 410 guests. This year the arrangement of the entertainment features of the program were in the hands of the newly appointed committee on Meetings of the Society in New York, Prof. Walter Rautenstrauch, Chairman. Through their action a committee on entertainment was formed, Edward Van Winkle, Chairman; a committee on excursions, Fred H. Colvin, Chairman; on acquaintanceship, R. V. Wright, Chairman; and a sub-committee on finance, Frederick A. Waldron, Chairman. The Bureau of Information was in charge of Professor Rautenstrauch. As a result of their efforts the visiting members and guests were afforded a thoroughly enjoyable time, with excursions of unusual interest. The reception given by Mr. and Mrs. Westinghouse on Thursday afternoon at the Hotel St. Regis contributed much to the pleasure of the convention and the usual evening receptions and the lecture by Dr. Georg Kerschensteiner were largely attended and brought out many expressions of commendation for the excellence of the arrangements.

OPENING SESSION, TUESDAY EVENING

As on the year previous, the president's reception on Tuesday evening was held in the rooms of the Society, which are well adapted to a gathering of this kind and are most attractive with their new furnishings and decorations. The evening opened with a session in the auditorium for the reading of the presidential address by the retiring President, George Westinghouse, who gave an account of the conception and development of the air brake which has constituted so large a part of the life-work of Mr. Westinghouse and has made possible the wonderful advance throughout the world resulting from modern transportation facilities. Following the address George A. Orrok for the Tellers of Election of Officers announced the names of the newly elected officers for the coming year, consisting of E. D. Meier, President; George M. Brill, E. M. Herr, H. H. Vaughan, Vice-Presidents;

D. F. Crawford, E. B. Katte, Stanley G. Flagg, Jr., Managers; and Prof. F. R. Hutton and Dr. Alex. C. Humphreys escorted the President-elect to the platform. Dr. Humphreys introduced President Meier with a few words of appreciation, to which he responded as follows:

I appreciate fully your kind confidence in bestowing on me the highest honor which can come to an American Engineer, and the grave responsibility its acceptance impose. But it is one of the glories of our noble profession that it gives great opportunities for service to our fellow men; and duty well done is its own best reward. This is strongly impressed on me by the simple, modest story your retiring president has just read to us, but which commemorates one of the most valuable services rendered to the whole civilized world in this age of engineering.

Remembering that his life work came after his youthful patriotism had rendered service in our old navy, I will remind you that while life lasts the old army boys are just as ready for duty as the tars; still we two are perhaps the last of the boys of the early sixties on whom you can confer this honor.

At the reception in the rooms the members and guests were received by the President and Mrs. Westinghouse, President-elect Meier, the Misses Meier, and Honorary Secretary Hutton and Mrs. Hutton, and the Secretary and music and refreshments added to the pleasure of the gathering.

WEDNESDAY MORNING SESSION

The first professional session of the meeting opened with the annual business meeting, President E. D. Meier in the chair. The Secretary read the report of the Tellers of Election to Membership which will be published in The Journal in the membership list of the Society. The list included 131 applicants for membership and 16 for advance in grade.

Worcester R. Warner, Past-President, reporting on the status of the Land and Building Fund, said that $88,920.03 had been received to date, leaving $85,765.03 to be raised. Mr. Warner supplemented his recital of the figures by an account of the efforts of the Committee in securing contributions. One firm which had previously contributed $1000 added an equal amount and a check for $500 from the president of the company. There were other instances of generous contributions and certain of them, though of considerably smaller amount, came from members who must have made a personal sacrifice. Many, however, have not contributed at all and still others have sent contributions which it is hoped will be supplemented by additional amounts.

The President then announced that the discovery had recently been made of a slight discrepancy in the charter under which the Society now acts, relating to the date of the Annual Meeting. The matter was referred to the Committee on Constitution and By-Laws, who had drawn up a certificate to be voted upon by ballot at the meeting and to be filed with the Secretary of State to the effect that it is intended to amend the present articles of incorporation and to make them conform with the Constitution. Jesse M. Smith, Past-President, read the certificate for the Committee and moved the adoption of the following resolution, which was seconded by W. F. M. Goss.

Whereas, The annual meeting of this Society has been for many years begun on the first Tuesday of December of each year; and

Whereas, The Constitution and By-Laws of the Society provide that the annual meeting shall begin on the first Tuesday of December in each year; and

Whereas, The Constitution and By-Laws provide for, and the election of officers has been, for many years past, by letter-ballot, cast prior to the beginning of the said annual meeting; and

Whereas, Upon the consolidation of this Society with the Mechanical Engineers' Library Association in 1907, the agreement of consolidation inadvertently provided that the annual election should be held on the second Tuesday of December in each year; and

Whereas, The Society has, in each year since that date, had its annual election by letter-ballot prior to the beginning of the said annual meeting, and has begun its annual meeting on the first Tuesday of December in each year, both in accordance with the Constitution and By-Laws of the Society; and it is the desire of the members that the annual meeting and annual election should be held in accordance with the said Constitution and By-Laws;

Now, therefore, be it resolved, That the time of beginning the annual meeting of this Society and the time and manner of holding the annual election of officers of the Society, be changed from the second Tuesday of December in each year, and be held at such time and in such manner as shall be provided in the Constitution and By-Laws of the Society.

After the resolution had been debated the Chairman appointed tellers of the vote for whom I. E. Moultrop announced that the resolution had been duly carried.

F. R. Hutton called attention to the need in this country of an adequate museum of engineering in which could be recorded the developments in engineering processes through models and apparatus, referring to the museum at Munich as an example of what could be accomplished. Several others followed emphasizing in their remarks the benefits to be derived from such museums and referring to similar

institutions in Europe, especially that at Munich. President E. D. Meier stated that over $4,000,000 had been received to erect a building for the exhibits contained in the Munich museum, and this in the small country of Bavaria. Attention was called to the efforts of the Smithsonian Institution in this direction. The Secretary stated that a room in the Engineering Societies Building was available for the beginning of such a museum.

Frank B. Gilbreth said, that as it was in order to make suggestions, he wished the Society would consider the advisability of a central bureau for the collection and preservation of data relating to scientific management. The work involved in the obtaining of original data seems an unnecessary expense and there should be a central bureau on the same plan as the government bureaus, where the results of investigations of others can be placed at the disposal of any who apply. C. E. Lucke of the Committee on Meetings said that his Committee had this particular question under consideration with plans relating to it and had recommended the appointment of a special committee to take up all of these relating subjects.

President E. D. Meier then referred to the address of the retiring President, George Westinghouse, given on the previous evening, in which was told the history of the great invention which had covered the entire world and made the name of Westinghouse known wherever an iron wheel rolls on a steel rail. Many a man considers himself an inventor when he brings out an idea. That is the first step and the next is to embody the idea in practice. Here difficulties arise such as Mr. Westinghouse referred to so easily, almost playfully, but which were actually very grave. If he had not been a man of powerful physique, he would not have been able to carry through his undertaking. The great inventor is not the one who has the first idea, as the public sometimes imagines, but one who works continuously through years of time for the perfection and application of the idea.

That is essentially the work of the engineer, and engineers can be proud of their contribution and of the fact that the whole progress of the world for the past fifty years has depended on the engineer in one way or another.

James M. Dodge, Past-President, followed with a motion of a vote of thanks to Mr. Westinghouse for his admirable and interesting address, which was unanimously carried by a rising vote.

The President then referred to the sad announcement which he had made on the previous evening, of the sudden death of William H. Bryan, Chairman of the Committee on Meetings of the Society in St.

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Louis, who had risen to distinction in the engineering world through his own energy and ability. He was a personal friend with a wide acquaintance in the Society and had recently passed through a strenuous competitive examination for the appointment as Chief Engineer for the School Board of the City of Chicago, in which he had won and had secured the appointment.

L. R. Pomeroy of the Committee on Meetings of the Society, of which Mr. Bryan was also a member, offered the following resolution of condolence which was unanimously passed:

Resolved: That the members of The American Society of Mechanical Engineers assembled in Annual Meeting, having heard of the death of their fellow member, William H. Bryan, hereby express their sense of loss, appreciation of his services to the Society, and sympathy for his family.

It is further

Resolved: That a copy of this resolution be sent to his family.

Dr. John A. Brashear, Hon. Mem. Am. Soc. M. E., asked for suggestions from members of the Society regarding the Carnegie Technical Schools at Pittsburgh. The original intention of Mr. Carnegie was that the schools should be for the education of young men and young women who worked for their living, but that the institution had grown until it had taken high rank among technical institutions. There are now 2250 students with a waiting list of 2500. The schools have the support of trade unions which have recently contributed $35,000 towards the work.

Dr. Brashear said also that he had recently had a quarter of a million dollars placed in his hands by a citizen of Pittsburgh for the betterment of teaching and teachers in the public schools, and that when members of the Society went to Pittsburgh they should not think of its smoke alone, but of the efforts which were there being made to give workers a chance to earn a livelihood, to learn something and to be helped to positions of usefulness. One of the most beautiful things in this world is to help our fellow-man and only by this means will our work be well done.

The President asked that any who had suggestions to make regarding the place for the Spring Meeting should express their preference to members of the Committee on Meetings while in attendance at the Annual Meeting, and said that it would be agreeable to many if the next one could be held in the West, in view of the fact that the two last Spring Meetings had been in the East.

James M. Dodge, Past-President, Chairman of the Committee on Public Relations, said that whereas other committees of the Society

were working for the development of the Society itself, his committee had been appointed to look after the welfare of the profession at large. The work was but just beginning, the committee would gladly receive suggestions, and hoped to report substantial progress at the next meeting. One question under consideration was that of licensing engineers. It is not a simple problem, owing to the fact that there are both graduate engineers, so-called, and those who graduate from the school of experience.

Dr. Hutton followed with an invitation to visit the Museum of Safety in the Engineering Societies' Building, New York.

WEDNESDAY MORNING—PAPERS AND ADDRESSES

Following the business meeting the Honorary Secretary and the Secretary presented reports of the Joint Meeting of the Society with the Institution of Mechanical Engineers, held in Birmingham and London in July 1910. Dr. Hutton spoke as follows:

It may not be known to all the members of the Society that its Secretary and its Honorary Secretary were made appointees to the Joint Meeting of the American and British Societies of Mechanical Engineers in Birmingham, England, in July 1910. It seems therefore proper that something of an official report should be presented from these officers respecting that meeting. The Secretary has already reported in full upon the outward and visible elements of the meeting; there is left for the other officer to report at your request upon some of the inner and therefore perhaps broader significances of such a gathering

These would appear to be three-fold: first, to the members of the American Society participating; second, to the American Society as a whole; third, to the members of the British Society, and to the engineering profession as a whole.

To the members of the American Society participating, it is superfluous to speak of the personal pleasure of the trip. The ocean voyage was a yachting party of congenial friends with every appointment of luxury at their service. The sojourn in England was a house-party or week-end visit at a hospitable manor-house, whose hosts could not do too much to keep their guests busy and interested while the beauty and historic interest of the Midlands were a background for every excursion. But besides this, so intimate an association for twelve days means the changing of acquaintances into friends. The shared memories are bonds which will not easily

break; and the Society, made up in some cases of competitors in business who are now personal friends withal, is the stronger for the meeting of 1910.

The significance of the British Joint Meeting to the American Society as a whole is in the compliment paid to the visitors by the hosts in and around Birmingham and London in according to American engineering the standing of which such courtesies are the evidence. It dignifies a body of visitors when the scale of their reception is an indication that they are regarded as being "worth while." The reception by city officials on landing, the courtesies of the Lord Mayor of Birmingham, and the civic splendor of receptions at the Mansion House and in the City Gardens at Birmingham, do not pass to inconsequential outsiders. The whole profession is helped upward and forward by an atmosphere such as this.

In the third place the meeting should be memorable to the British Institution and to the profession at large, because of the topics selected for the American papers, the manner of their presentation and the quality of the discussion on them, and the representative character of the American deegates. The whole participation in the duties of the meeting by the official party was creditable and distinguished. Its influence will be favorably felt for many days.

It was the privilege of the Honorary Secretary in the regretted absence of the President of the Society to respond by request of his associates to the toast of The American Society of Mechanical Engineers at the great banquet in London with which the meeting closed. The sentiment was proposed by Sir William H. White, Past-President of the Institution. The substance of the speech of reply was forced upon a plane of dignity and earnestness by the proprieties of the occasion. Its leading features were:

That any event falls in the class of memorable or of commonplace happenings according as its inner or spiritual meaning is elevated or ordinary. The gathering at Runnymede was but a seditious uprising, unless we see in it the dawn of the philosophy that government is only stable when it secures the greatest good to the greatest number, the principle underlying the triumph of enlightened democracy in America and of constitutional government in England. The death of the Stuart Charles is but an insurrection and an assassination, unless there is seen behind it the lesson that no King "liveth unto himself." Here a tribute was paid to the self-sacrificing industry and devotion of King Edward VII for whom the land was then in mourning.

What were the significances of this Joint Meeting? Certainly threefold. There was first the fact that visitors from the United States were guests of the mother-country. Why does the American regard Old England as his home-land, even if he were not of English descent? It is more than the common language which underlies this; for many Americans have the languages of Europe as their own and the open doors to the literature of the Continent. The reasons seem deeper in philosophy and sentiment. To use a figure to bring out the thought, the civilizations of the world may be viewed as structures standing like pyramids on a plain. Research below the visible phenomena will show that the existing civilization has beneath it the customs of the people; below the customs and laws of the people are the conduct and examples of the individual units who make up the people. The source and origin of this behavior are the ideals and inspirations in the soul of the man, having as a rule their basis in his concept of his relation to a personal God or great spiritual first cause. Now the reason the American and the Briton are so near each other and understand each other so well, is that on the courses of the foundation of our respective civilizations where you come to the deep levels of the ideals and inspirations of conduct, the two nations are at one. No one but a sharer of our ideals could have made us tingle and thrill as we do under the spell of Kipling's Recessional; no one but an Englishman could have moved us as he who describes the self-immolation of the noble physician in the Bonnie Briar-Bush; no poet but an English one would have conceived that splendid ideal of a manly death at "Twilight and evening star," and "one clear call for me," with its hope to meet a "Pilot at the bar, when we put out to sea." The Americans rejoice to be the guests of men, sharers of our ideals.

But the Joint Meeting is not alone of Americans and English, it is of engineers, American and English. Our data of science are the same; the equation of the parabola, or the exponential expression for the expansion of steam under adiabatic assumptions are not changed as we cross the Atlantic. Why then the stimulus each feels in rubbing shoulders with the other? It is that economic conditions and the conditions of industrial production are different in the two countries. With the American the trend of successful production is in the direction of standard product as against special designs. In other words we seek to induce and persuade the buyer to adjust himself to such standard, rather than to have the buyer compel the seller to make special designs to meet a requirement which was

in most cases somewhat accidental and not unmodifiable. In economic terms, the American plan is to have the seller write the specifications; the English plan is to have the consulting engineer for the buyer write them. This difference explained American successes in recent competitive history, and threw a strong light on one phase of the "American peril." When the Briton woke up to the advantages of the other system, the days of certain supremacies would be numbered.

In the third place, this meeting was the successor of other transatlantic interchanges, beginning in 1889, repeated in 1893, 1900 and 1904 when the Institution came to Chicago and St. Louis for a visit; and to this last the present meeting was the return match or home game in the speech of the national sport.

Finally, did such a reunion of the great productive engineers of the English-speaking peoples, rejoicing in the same high ideals impose on the two bodies any responsibilities and obligations. Doubtless many, but at least one. The duty of the designer of machines and the manager and director of works to safeguard his work-people at their occupations, that useless and unnecessary loss of life or limb or wage-earning capacity was not entailed where it could least be borne. The air of America was vibrant with the sense of duty to prevent accident in factory and shop; and this was first the duty and opportunity of the trained mechanical engineer. To paraphrase the historic vision of the first violent death in our race: when Cain the older brother, the leader of men, the employer by temperament and gifts shall be asked, "Where is thy brother? The voice of thy brother's blood maimed or slain in a factory accident crieth out from the ground," the enlightened sentiment of all of worthy ideals will not allow him carelessly and indifferently to answer, "Am I my brother's keeper?" The mechanical engineer is responsible before the bar of the highest justice for any industrial accident which he could have prevented and did not interest himself to forestall. Let us see to it that this sin is not laid to our charge.

The Secretary then presented his account of the events of the trip and of the meetings, and spoke in particular of its international character of the gathering and of the impressive service in Westminister Abbey. He went on to speak of the national work of the Society, as evidenced in the recent organization meeting in San Francisco.

A paper by George A. Orrok of New York on The Transmission of Heat in Surface Condensation was then presented, which dealt with

the results of 771 heat transmission tests made on 16 kinds of condenser tube under the various conditions of condenser practice. The conclusions drawn by the author from these and other tests include a statement of the law of heat transmission in condenser practice, with reference to mean temperature differences, velocity of cooling water, effect of air leakage and effect of the material of which the tube is made. The paper was discussed by W. F. M. Goss, W. D. Ennis, Wm. Kent, H. H. Suplee and Thomas C. McBride.

WEDNESDAY AFTERNOON—STEAM ENGINEERING

The session of Wednesday afternoon was devoted to papers on Steam Engineering.

The first paper presented was by Edw. A. Uehling of Passaic, N. J., on Combustion and Boiler Efficiency, and maintained that the efficiency of the steam generator depended on conditions far more complex than the steam engine or dynamo. The importance of knowing the percentage of CO_2 in the flue gas and the stack temperature, which are the controlling factors in steam boiler economy, were particularly dwelt upon. The paper was discussed by C. H. Bathgate, W. D. Ennis, Wm. Kent. D. S. Jacobus, John C. Parker, A. W. K. Billings and H. C. Abell.

This was followed by a paper on The Automatic Control of Condensing Water, by B. Viola of Brooklyn, N. Y., which gave particular attention to barometric counter-current condensers in connection with vacuum pans, and was illustrated with many recording charts taken during operation. This was discussed by George Dinkle, Watson C. Shallcross and E. D. Dreyfus.

Two accounts of turbine tests were then presented, one on a 10,000-kw. Steam Turbine, by Sam. L. Naphtaly of San Francisco, giving the results of steam economy tests on a unit at the plant of the City Electric Company, San Francisco, with a description of methods, apparatus, and application of correction factors to meet specified conditions; and the other on a 9000-kw. Turbo-Generator Set, by F. H. Varney of San Francisco, with a description of tests and results. These were discussed by J. W. Lawrence, D. S. Jacobus, I. E. Moultrop, George A. Orrok, E. D. Dreyfus, Francis Hodgkinson, R. J. S. Pigott, W. L. R. Emmet and W. L. Waters.

The final paper of the session was by Isaac Harter, Jr., of Bayonne, N. J., entitled Notes on the Value of Napier's Coefficient with Superheated Steam, comprising a series of determinations of the value of

the coefficient for steam at pressures closely averaging 160 lb. per sq. in. abs., and for various degrees of superheat ranging approximately between 50 and 200 deg. This was discussed by Henry E. Longwell and Prof. R. C. H. Heck.

WEDNESDAY EVENING

A reunion of the membership of New York in honor of the newly-elected officers and visiting members of the Society, their ladies and guests, was held at the Hotel Astor on Wednesday evening, December 8. Dancing was begun at nine o'clock, those who did not care to participate occupying boxes, and supper was served during the intermission. The occasion, like those of a similar nature of previous years, was greatly enjoyed by all, and added much by the renewal of old acquaintances and the making of new ones, to the social side of the convention, emphasizing as it did the general feeling of friendliness which was so evident throughout the entire series of meetings.

THURSDAY MORNING SESSION

At the Thursday morning session four papers were read upon miscellaneous subjects. The first, A New Theory of Belt Driving, by Selby Haar of Schenectady, N. Y., presented a theory of the process by which a belt transmits power and a study of the losses occurring in the belt while under load, so that its efficiency may be determined. The paper was discussed by Carl G. Barth, Geo. N. Van Derhoef, H. G. Reist, A. F. Nagle, Harrington Emerson, F. W. Taylor, T. M. Phetteplace, George I. Rockwood and Wm. Kent.

A Graphical Method for Calculating Stresses in a Connecting Rod, by W. H. Herschel of New York, followed, which dealt with a method for finding stresses at any point of a rod of any shape. This was discussed by L. L. Willard.

Operating Conditions of Passenger Elevators was presented by Reginald Pelham Bolton of New York, who directed attention to the effects upon elevator work and economy of the passenger movement and traffic by reducing the period of actual motion and by increasing the time occupied in the operations of starting and stopping. It was discussed by Emanuel Hollander.

The fourth paper presented was upon Modern Shoe Manufacture, by M. B. Kaven and J. B. Hadaway of Beverly, Mass. This treated of the ancient methods of covering the feet, the old-time shoe shop

in which each workman was taught to make the entire shoe, the making of the hand-sewed shoe, the advent of the sole-sewing machines, the direct means of revolutionizing the shoe industry, and subsequent inventions substituted for hand work which finally led to the building of the modern shoe factory. Mr. Hadaway who presented the paper illustrated his remarks with some samples of the welt shoe which he had brought with him. The paper was discussed by Edwin J. Quinlan, Edward Robinson and R. H. Long.

THURSDAY AFTERNOON—MACHINE SHOP SESSION

Three papers on Grinding were presented on Thursday afternoon at a Machine Shop Session, the first, The Field for Grinding, by C. H. Norton of Worcester, Mass., dealing with the new idea of grinding as quick cutting, rapid reduction of stock, accuracy and economy, with modern machines, modern wheels that cut and do not abrade, and a knowledge of the science of the process, which, the author believes, is worthy of systematic coöperation on the part of the engineer. The second paper, Precision Grinding, by W. H. Viall of Providence, R. I., discussed grinding as an art, especially as related to the manufacturer's problems where not only the nicest accuracy is obtained, but where the rate of production is an important consideration. Modern Grinding Methods, by B. M. W. Hanson of Hartford, Conn., was the last of these papers, and described recent developments in grinding machines for cylindrical work and plane surfaces, with an account of new features of the cylindrical grinder whereby the work is sized automatically, and illustrations of pieces ground on a surface grinder, using a cupped wheel on a vertical spindle, which has a high rate of production. These papers were discussed by W. L. Bryant, A. L. DeLeeuw, H. A. Richmond, Geo. M. Jeppson, Henry Hess, Henry M. Leland, Oberlin Smith, O. Junggren, and J. Wendell Cole.

THURSDAY AFTERNOON—GAS POWER SESSION

At the meeting of the Gas Power Section, also held on Thursday afternoon, the annual address of the Chairman was made by James Rowland Bibbins, on Gas Power Development. Reports were received from committees, the Membership Committee reporting a steady and normal growth of high quality.

The Literature Committee had already published its results from

time to time in The Journal, but expected even better results during the year before the Section.

The Research Committee announced that its work had been turned over to the Research Committee of the Society. The Installations Committee reported progress and the Standardization Committee, having completed its work, was discharged. The Committee on Operations did not present a report in writing, but I. E. Moultrop, Chairman, announced that data from three or four producer gas power plants were expected shortly.

The Committee on Elections announced the following officers elected: Chairman, R. H. Fernald; Member of the Executive Committee, C. J. Davidson. The Chairman-elect was then escorted to the chair by Professor Breckenridge.

Two professional papers were also presented at this session, the first that by the late E. P. Coleman of Buffalo, on the First Large Gas-Engine Installation in American Steel Works, presented by E. E. Kiger, which described in a very thorough-going manner an installation made in the Lackawanna Steel Company with which Mr. Coleman was connected. From the viewpoints of continuity and reliability of service the installation was considered successful, and the economy of heat consumption was considerably in excess of that usual with compound steam engines. The paper was discussed by Joseph Morgan, Wm. A. Bole, George A. Orrok, Edw. A. Uehling, Charles Whiting Baker, E. D. Dreyfus, E. E. Kiger, George D. Conlee, and Louis Doelling.

A paper by Nisbet Latta of Milwaukee, entitled Notes on a Heavy-Duty Gas Producer, was then presented, in which the author called attention to the recent development of the heavy-duty gas engine and to the fact that the gas producer had not been developed of proper size and type to accompany these large units. Recent experiments on pulverized coal and air in the proportions required to burn the carbon to CO were also described. The paper was discussed by W. B. Chapman, W. E. Winship, and L. B. Lent.

THURSDAY AFTERNOON

On Thursday afternoon Mr. and Mrs. Westinghouse received the members and guests of the Society at the Hotel St. Regis from four to six o'clock. The delightful hospitality of the host and hostess, with which the Society has had opportunity on previous occasions to become acquainted, made this occasion one of the most enjoyable

social events of the Annual Meeting, and it was very largely attended, affording an opportunity to extend to Mr. and Mrs. Westinghouse a personal greeting.

THURSDAY EVENING

The concluding gathering of the Annual Meeting was on Thursday evening, when an illustrated lecture was given by Dr. Georg Kerschensteiner, Superintendent of the Industrial Continuation Schools of Munich. This address was a noteworthy addition to the attractive lectures which have been given at each of the recent Annual Meetings. Dr. Kerschensteiner has not only achieved marked distinction through his original and effective methods for industrial training but he is an entertaining speaker, and in presenting the subject used a remarkable collection of slides from views showing classes at work in the varied lines of industry in which the students of Munich are given practical instruction. These not only include the more familiar occupations, such as work in the machine shop, foundry, pattern shop, etc., but a great variety of miscellaneous occupations ranging from the artistic to the most utilitarian, such as the supply of food and the manufacture of common implements and utensils. The Society was able to enjoy this lecture through the National Society for the Promotion of Industrial Education, who had arranged for an address by Dr. Kerschensteiner in New York, and the meeting was held by them at this time, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers coöperating.

EXCURSIONS

A very fine program of excursions, sufficiently varied in their nature to meet all tastes, had been arranged by the committee in charge, F. H. Colvin, Chairman, and to these Friday, December 9, was entirely devoted. Many availed themselves of the opportunity of visiting the New York Public Library at Fifth Avenue and 42d Street, W. W. Christie acting as guide. The building which will not be opened to the public until May 1911 is, however, practically complete as to its interior decorations, with the exception of pictures and furniture, and a very good idea was gained of the appearance which it will present. The visitors were especially interested in the very fine marbles and woods as well as other materials which have been employed in its construction, and in the workmanship which is to

be seen throughout the building, presenting a finished result which may be favorably compared with other public buildings throughout the United States. The various automatic devices for the speedy delivery of books to the reading room, the wilderness of steel shelves in the stack rooms, and the printing and binding machines, were also interesting features.

A party of 25 took advantage of the invitation to visit the plant of Nelson Goodyear, Inc., Brooklyn, N. Y., to witness the process of oxy-acetylene welding. The party was conducted by E. H. White and was shown the new type of generator and the torches used by this company. Demonstrations of welding and cutting metals were made, after which there was a demonstration by Mr. André Beltzer of the welding and soldering of aluminum by the use of a new flux for this purpose.

About a dozen members visited the Hudson and Manhattan Power House in Jersey City, under the guidance of W. B. Yereance, where they inspected the generating plant for the Hudson River tubes, known as the McAdoo tubes, a trip made possible through the courtesy of Mr. G. McAdoo. They were met at the power house by Chief Engineer Sage who personally conducted the visitors through the plant and explained the different features and the reasons for their adoption by those in charge. Some of the members of his staff had also been detailed to answer individual questions or to explain features in which any one might be especially interested.

A party of 60 were conveyed by special car to the works of the Pond Machine Tool Company at Plainfield, N. J., under the guidance of W. L. Clark, where several of the recently developed reversing motor planers were in operation and various tests were made for the benefit of the visitors. Other special machines as well as the regular processes proved of much interest and appreciation was expressed on all sides of the interesting visit. Through the courtesy of the company luncheon was served at the plant, and a special car conveyed the visitors to the city.

A party of 20 under the guidance of L. P. Alford visited the Thompson-Lovelace Aeroplane factory at Fort George, New York City, and this proved to be one of the most interesting excursions. The machine used by Moissant in his flight from Paris to London was on exhibition, completely assembled, and another machine was in process of erection for Moissant for the flight which he is to undertake in February from Key West to Havana. Various engines and parts of aeroplanes under construction were shown the visitors.

The excursion party to the yard of the John N. Robins Company, Erie Basin, Brooklyn, though not large was composed of those especially interested in the application of electricity to this class of work, and particular interest was shown in the application of high tension, 6600 volt motors to the driving of air compressors; also, the pumping of basin dry docks by direct connected 6600 volt motors driving 30-in. centrifugal pumps. The large machine shop and boiler shop were also visited and the floating dry docks inspected, the new floating dry dock with steel wings and wooden pontoons coming in for particular attention.

A party conducted by S. B. Redfield spent the afternoon on Friday in the Spring Street Telephone Exchange and in the Long Distance Exchange on Cortlandt Street. The visitors were given an opportunity to see the work of the training school for telephone operators, which graduates 40 operators a week for the supply of the New York exchanges, and were shown the operation of the switchboards in the main room where 200 operators are in constant attendance. The procedure in securing a long distance call and in keeping track of the time and of the charges, and plans under way for securing even quicker service than is now obtained, were explained in detail by the representatives of the telephone company who accompanied the party.

Several of the members also visited the Navy Yard in Brooklyn.

In addition to the excursions which were participated in on Friday, a number of invitations had been received of which the members were at liberty to take advantage any time during the meeting. These included the Metropolitan Building, where Mr. Charles S. Bavier, chief engineer, received the visitors; the Interborough Power House, the Hill Publishing Company, the Waterside Power Plant of the New York Edison Company, Sims Magneto Company at Watsessing, N. J., the National Lead Company in Brooklyn, and the high-pressure fire-pumping stations of the Board of Water Supply of New York.

A party of the ladies who attended the Annual Meeting visited the Franco-American Food Company's factory in Jersey City on Wednesday morning and were escorted through this model plant by a special conductor. On Friday afternoon a trip was made to the Colgate factory in Jersey City which was also much enjoyed.

Every possible courtesy was extended to the visiting party at all these excursions and much appreciation was expressed to those who made the trips possible by throwing open their works to the Society. Material aid was rendered by the Information Bureau located in the foyer of the Engineering Societies Building.

ENTERTAINMENT FEATURES

As has been the custom for several years past, a number of the ladies resident in and about New York formed a Reception Committee, under the Chairmanship of Mrs. Herbert Gray Torrey, and added much to the social side of the convention by their entertainment of the visiting ladies and members. Tea was served on Tuesday and Wednesday afternoons, Mrs. John W. Lieb, Jr., acting as hostess on the former occasion, and Mrs. Jesse M. Smith at the latter. A Guides' Committee, Dr. Lucy O. Wight, Chairman, conducted parties to points of interest about the city, including the shops and hotels.

MEETINGS OF THE COUNCIL

DECEMBER 6

A meeting of the Council was held in the rooms of the Society on the afternoon of Tuesday, December 6, 1910, with President Westinghouse in the Chair. There were present Messrs. George M. Bond, Chas. Whiting Baker, R. C. Carpenter, H. L. Gantt, W. F. M. Goss, James Hartness, Alex. C. Humphreys, F. R. Hutton, E. D. Meier, I. E. Moultrop, H. G. Reist, W. J. Sando, Jesse M. Smith, Fred. W. Taylor, Worcester R. Warner, Fred. M. Whyte and the Secretary.

The minutes of the meeting of November 16 were read and approved.

Jesse M. Smith reported for the Committee on Constitution and By-Laws on the question of the change of date of the Annual Election and Meeting as stated in the Charter, and the desire to make it uniform with the Constitution and By-Laws. After reading the petition as drafted by the Attorney of the Society, it was

Voted: That the Secretary arrange for the formal presentation of the matter at the regular business session of the Annual Meeting, and that the same be duly executed and the record filed with the Secretary of the State of New York.

The Secretary reported the following deaths: George H. Baush, Lewis Johnson, S. W. Robinson, S. E. Stokes, E. P. Coleman and James Macpherson.

The Secretary read letters of appreciation from Messrs. S. B. Whiting and E. F. Mattes upon whom the Council had conferred Life Membership.

Voted: To refer to the Committee on Meetings the invitation from members in San Francisco to meet in that city for the semi-annual meeting of 1915, the year of the celebration of the opening of the Panama Canal.

Professor Hutton, Chairman of the Committee on Affiliated Societies, presented a letter from the Committee of the Providence Association of Engineers, concerning affiliation with this Society.

Voted: That the communication be received and the proposition for affiliation accepted with the understanding that the joint meetings of the two societies as stated in the application be understood to mean coöperative meetings as defined by the Committee on Meetings of this Society.

Voted: That the Annual Report of the Council covering the work of the year, including the reports of the Finance and other Standing Committees, be adopted and ordered read at the Annual Meeting.

Voted: To accept the following resignations: Guy Hopkins, New Orleans, La., Chas. A. Fingal, Chicago, Ill., C. A. Wettengell, Caney, Kansas, Burt S. Harrison, New York, C. G. Atwater, New York, W. B. Ridgely, Washington, D. C., and Herman M. Sage, Hawthorne, Ill.

Voted: To reinstate Thomas M. Keith, H. H. Dixon and W. F. Evans.

Professor Hutton presented his report of the Joint Meeting in England. It was the sense of the Council that he be asked to present this at the regular business session of the Annual Meeting on Wednesday morning.

This being the last meeting of the Council, on motion of Worcester R. Warner, Past-President, the members gave a rising vote of thanks to the retiring President, Mr. Westinghouse, and to the members of the Council of 1910.

The meeting adjourned.

DECEMBER 9

A meeting of the Council for the year 1910–1911 was held on Friday, December 9. Mr. George Westinghouse called the meeting to order and appointed Jesse M. Smith a committee to introduce E. D. Meier, the President-Elect, W. F. M. Goss to introduce G. M. Brill, Vice-President-Elect, and I. E. Moultrop to introduce E. B. Katte, Manager-Elect.

There were present E. D. Meier, President, in the Chair, George Westinghouse, F. R. Hutton, Jesse M. Smith, James Hartness, W. J. Sando, I. E. Moultrop, H. L. Gantt, George M. Brill, E. B. Katte, Chas. Wallace Hunt, W. F. M. Goss, H. G. Reist, Chas. Whiting Baker, Fred. W. Taylor and the Secretary. Regrets were received from Manager-elect Stanley G. Flagg, Jr.

The minutes of the meeting of December 6 were read and approved.

Voted: That Calvin W. Rice be appointed Secretary of the Council and the Society for the coming year on the same terms and conditions as last year.

Voted: That Prof. F. R. Hutton be appointed Honorary Secretary on the same terms and conditions as last year.

The Secretary reported a vacancy in the list of Vice-Presidents in the unexpired term of E. D. Meier, elected President of the Society, same to be filled under provisions of C 29. The Secretary was requested to cast a ballot representing the unanimous choice of the Council that Dr. Alex. C. Humphreys be appointed Vice-President to fill the unexpired term of E. D. Meier.

Voted: That John A. Brashear, Honorary Member, be appointed the representative of the Society on the John Fritz Medal Committee under the provision of C 46, to serve for a term of four years.

Voted: That Chas. Wallace Hunt, Past-President, be appointed Trustee of the United Engineering Society to serve for a term of three years under the provisions of By-Law 32, to fill the vacancy created by the expiration of the term of office of F. R. Hutton.

The death of Wm. H. Bryan, of St. Louis, was reported.

THE ANNUAL REPORT OF THE COUNCIL, 1910

The Council presents the following summary of the activities of the Society, supplementing the reports of its Standing Committees, which are part of the report.

The Council has held nine meetings during the administration year, from December 1909 to December 1910.

HONORARY VICE-PRESIDENTS

In response to invitations representatives have been appointed on the following occasions:

Jan. 17–19, National Civic Federation Conference in Washington, D. C., on Uniform State Legislation, Jesse M. Smith, Past-President, Chas. Kirchhoff, A. W. Burchard, E. G. Spilsbury, Fredk. M. Whyte, Vice-President, and Major Wm. H. Wiley, Treasurer of the Society; Sept. 26–30, National Irrigation Congress, Pueblo, Colo., C. H. Williams, Denver, Colo.; Sept. 5–9, Second National Conservation Congress, St. Paul, Minn., Paul Doty, J. J. Flather, L. H. Gardner, E. E. Johnson and M. E. R. Toltz; Sept. 27–29, Inauguration of President McVey, University of North Dakota, Calvin H. Crouch; Sept. 26, October 1, American Mining Congress, Los Angeles, Cal., H. H. Clark and Robert Linton; funeral of Chas. T. Porter, Honorary Member, Montclair, N. J., Alex. C. Humphreys, Hosea Webster, A. E. Forstall and J. E. McIntosh; June 19–23, International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology at Dusseldorf, Chas. Whiting Baker, Vice-President; Mr. Baker was also appointed from the Department of State as delegate on the part of the United States; June 4, Opening of the Forest Products Laboratory of the University of Wisconsin, Madison, Carl A. Johnson and J. G. D. Mack.

In the matter of the American Year Book in coöperation with other societies, and in the securing of biographies of engineers in coöperation with the Verein deutscher Ingenieure, the Secretary has been directed to assist so far as possible.

The changes in membership are shown in the following table:

GRADE	OCT. 1, 1909	LOSSES				ADDITIONS		NET INCREASE	OCT. 1, 1910
		Transfer	Resignation	Lapsed	Death	Transfer	Election		
Honorary	15	....	....	....	1	....	1	...	35
Members	2483	....	13	13	31	28	155	126	2609
Associates	394	28	3	4	5	1	40	1 decrease	393
Juniors	834	1	16	20	1	....	86	48	882
Total	3726	29	32	37	38	29	282	173	3899
Affiliates of Gas Power Section								....	145
Affiliates of Student Branches								318	512

While there has been an absolute gain, it is smaller than that of other engineering societies.

It is hoped that the membership will take upon itself the acquainting of the leading engineers with the benefits of membership and the opportunity to extend its influence.

The following resignations were accepted during the year 1909–1910:

Edgmont B. Arnold, Jno. S. Avery, Richard C. Beverley, Albert E. Coleman, Asa S. Cook, Carl S. Dow, Harry Dunn, L. Hodgson, A. E. Holcomb, Zareh H. Kevorkian, George E. Kirk, Wellington W. Kuntz, W. A. McFarland, Henry E. Paine, R. Raymond, E. G. Rust, Foster C. Slade, Henry J. Scales, L. Searing, Ephraim Smith, J. E. Tatnall, Chas. J. Wachalofsky, Arthur S. Wardwell.

Membership which has lapsed during the year 1909–1910:

Arthur T. Alexander, Elmer T. Barnard, Wm. W. Bigelow, Frederick A. Boland, F. E. Bradenbaugh, James Breen, Jas. M. Briggs, E. D. Clarage, John G. Dodwell, Wm. F. Donovan, L. H. Gardner, Jos. N. Gregory, H. H. Hanna, Jr., Geo. O. Hodge, G. L. Holmes, Nathaniel Lombard, Chas. F. Meissner, E. E. Miller, John L. Mohun, Rafael de la Mora, James Naughten, Harvey E. Newell, W. Allen Pendry, H. W. Pudan, J. D. Ramsay, Warren B. Reed, Cyrus W. Robinson, D'A. W. Roper, Frederic Albert Schroeder, Edward Seaver, Jr., Robert M. Snyder, E. O. Spillman, George W. Stewart, Alfred A. Thresher, Chas. Henry Umstead, C. L. Weil, A. J. Wiechardt.

Members deceased during the year 1909–1910:

Mark Bary, Stephen Baldwin, Chas. Batchelor, Wm. P. Bettendorf, Jas. H. Blessing, J. H. Bloomberg, Jas. W. Bridge, Wm. W. Churchill, Chas. B. Clark, Wm. E. Crane, B. Cruikshank, Chas. B. Dudley, J. D. E. Duncan, R. W. Emerson, Jas. B. Faulks, Jr., C. F. Foster, Chas. H. Ferry, J. Garbett, A. M. Goodale, L. C. Grover, H. S. Haskins, Walter C. Kerr, John E. McKay, Wm. Metcalf, F. J. Plummer, Wm. N. Parsons, Chas. T. Porter, I. I. Redwood, P. A. Sanguinetti, T. H. Savery, Horace See, Gardner C. Sims, J. Henry Sirich, Jr., Wm. W. Snow, E. P. Sparrow, A. Spies, Chas. Swinscoe, C. H. Willcox.

On approval of the Membership Committee, John T. Jones and B. H. Cameron have been reinstated.

The Council has elected to Life Membership, S. B. Whiting and W. F. Mattes, who have been Members ever since the formation of the Society; and George W. Melville, Rear-Admiral, Past-President of the Society, has been made an Honorary Member.

On the Spring and Fall Ballots the following new members were elected and changes in grade of others authorized:

Elected June 1, 1910, Atlantic City: Members. W. J. Best, F. A. Blakeslee, Edward W. Brown, William L. Bryant, Henry Kenyon Burch, W. R. Carson, Cloyd M. Chapman, H. B. Chapman, Frank H. Clark, H. I. Cone, E. S. Cooley, E. H. Coster, A. D. Cressler, Byron Cummings, W. J. Davis, John A. Doane, D. Dorward, Jr., M. C. Ernsberger, R. W. Fenn, Harwood Frost, George W. Fuller, J. W. Fuller, Jr., David L. Gallup, Albert F. Ganz., Edwin S. Hallett, John Hays Hammond, W. H. Herschel, Alec. W. Hodgson, U. T. Holmes, F. Kingsley, A. Lebrecht, C. R. Lester, Wm. J. A. London, Harrison Loring, Jr., Chas. G. Lundgren, Adolphus A. McLeod, W. G. Marot, Irving S. Merrell, Frank H. Metcalf, John F. G. Miller, Lewis F. Moody, J. Wm. Neidhardt, Henry B. Oatley, Harry L. Parr, A. C. Paulsmeier, C. H. Peterson, Hollis P. Porter, Snowden B. Redfield, George R. Sanford, Eugene Y. Sayer, R. Schlatter, John J. Scollan, F. L. Sessions, W. C. Shallcross, Joseph D. Shaw, Elmer A. Sperry, Edson M. Stevens, Eliot Sumner, Theodore S. Tenney, W. E. Van Patten, V. S. Westcott, W. H. Whiteside, R. M. Wiggin, Paul Winsor, E. W. Wyatt, Lucien I. Yeomans, S. J. Zowski-Zwierzchowski; Promotion to Members. P. H. Batten, Frank Bishop, Jos. A. Bursley, Carl F. Dietz, R. W. Emerson, F. L. Kennedy, Roy Stevenson King, Frederick W. Mahl, S. M. Marshall, H. E. Satterfield, C. D. Young, John M. Young; Associates. Frank Burgess, S. P. Cobb, H. N. Cooley, Frank M. Sears, O. C. Thompson, Charles N. Thorn, Lawrence Whitcomb; Promotion to Associates. Wm. P. Hawley, Louis G. Henes; Juniors. M. L. Abrahams, John Adams, Alex. D. Bailey, Geo. A. Bancroft, Arthur F. Barnes, C. M. Barron, E. H. Bedell, Richard O. Bonner, J. B. Brady, Walter E. Brown, A. Bradley Burgess, Harold Thomas Carter, T. .D. Casserly, W. Van Alan Clark, H. H. Cook, William H. Cook, Glen H. Corlette, W. H. Correa, W. R. Crute, Geo. H. Cunningham, H. N. Davock, Ed. G. Dubarry, S. A. Ellenbogen, R. Emerson, H. V. Ennis, Stephen I. Fekete, J. O. Fisher, Walter J. Foley, George F. Gast, W. G. Gernandt, H. S. Gladfelter, Chas. C. Grant, Dwight K. Hall, H. D. Hartley, Fred M. Heidelberg, C. T. Henderson, Harry A. Hey ,Warren B. Hood, C. M. Husted, Austin D. Keables, H. B. Lange, W. H. Lines, J. Harold McCreery, H. B. McKibben, Thos. B. Morris, S. T. Mudge, B. S. Nelson, J. G. Painter, John H. Peper, Jr., William T. Price, Rudolph Roesler, Philip L. Ross, D. D. Rowlands, R. L. Rowley, R. P. Schoenijahn, J. T. Sharp, Jr., E. J. J. Sievers, Charles O'Conor Sloane, N. L. Snow, W. C. Sprau, R. K. Stockwell, Everett W. Swartwout, H. B. Taylor, Gerald E. Terwilliger, Charles Thoma, Jr., Walter Thoma, L. B. Webster, James L. Wick, Jr., R. A. Wilson, Forest E. Woodman, A. R. Zachert,

Elected December 7, 1910, New York: Members. Lawrence Addicks, Will H. Baltzell, H. H. Barnes, Jr., Dwight K. Bartlett, Oliver D. H. Bentley,

John C. Bird, George Wright Bowers, H. A. Brinkerhoff, Willard Brown, Forest E. Cardullo, J. D. Carr, Markham Cheever, Howard B. Clark, F. B. Cockburn, Arthur E. Cutler, Hans Dalstrand, W. R. Dunn, Charles L. Edgar, William J. Edwards, W. W. Erwin, Edmund H. Farquhar, John Fisher, Benjamin D. Fuller, Halbert P. Gillett, Philip M. Hammett, F. M. Hartman, J. R. Henderson, Chas. H. Herrick, Lewis A. Howland, Allen Hubbard, George Francis Hutchins, Chas. T. Hutchinson, A. L. Johnson, G. R. Joughins, O. F. Junggren, P. Junkersfeld, Karl W. Knorr, Gustav L. Kollberg, J. W. Ledoux, Norman Marshall, Frank Amedee Nazzur, Warren E. Murray, Walter S. Myers, Charles L. Norton, M. Webb Offutt, Francis Conrad Osborn, Oscar P. Ostergren, Perley Burnham Palmer, Geo. U. Poole, Edwin Jay Prindle, M. H. Putnam, Edward B. Richardson, Charles H. A. F. L. Ross, Will M. Sawdon, Phineas V. Stephens, Sidney Stevens, James Balboa Stokoe, Julian B. Strauss, Wm. Barrett Updegraff, E. Victoreen, G. R. Wadsworth, E. L. Walker, D. E. Washington, William P. Westcott, C. T. Westlake, Thos. R. Weymouth, Richard T. Wingo, John J. York; Promotion to Members. John H. Damon, James E. Gibson, Henry John Hanzlik, Arthur C. Jackson, Horace Judd, Wm. H. Kavanaugh, J. H. Maysilles, H. A. Moody, James A. Pratt, Geo. F. Read, Jr., Theodore Howard Taft, J. W. Taylor, J. G. Vincent, F. H. Vose, H. L. Whittemore, L. L. Willard; Associates. Freeman Field, Emil J. Heinen, M. T. Maguire, Ray Mayhew, John B. Perkins, W. R. Porter, G. E. Richardson, Arthur C. Scott,; Juniors. John F. Allison, Edward E. Ashley, Jr., H. Harding Bailey, W. J. Bailey, T. D. Banks, Henry C. Beckwith, Harry Lewis Benner, Myron R. Bowerman, Wm. Wallace Boyd, Harry S. Brown, R. U. Bunker, Herbert W. Carey, F. A. Collins, Jr., P. E. Cowgill, Magruder Craighead, Peter A. Cummins, Charles Iven Day, H. L. Doolittle, H. Alfred Ellis, John Fallon, W. W. Fisher, Arthur P. Gerry, Frank J. Gordon, Lucian L. Haas, H. F. Hallock, L. G. Hanmer, R. C. Hargreaves, Eugene Hunt, Frederick W. Ives, John R. James, Reid Jones, John P. Kottcamp, Milton Kraemer, Chas. H. Leaman, Nixon Lee, W. E. McCann, J. P. McJilton, W. R. McKinnon, C. H. Mount, John P. Mudd, Albin J. Nott, Harry Ottinger, H. H. Ramsey, John I. Rogers, Jr., James R. Rossman, Jr., Chris. A. Shearer, A. F. Sinclair, Harry St. Clair Spillman, Glegge Thomas, Robert H. Tifft, Albert C. Townsend, Samuel K. Varnes, Joseph W. Wattles, 3rd, Erwin L. F. Weber, Hugo W. Weimer.

MEMBERSHIP COMMITTEE

The Membership Committee have recommended this year for ballot 306 candidates, including 30 candidates for promotion, as compared with 339 last year, including 45 promotions. The general financial conditions prevailing in the country and the strictness with which the Committee is scrutinizing applications perhaps account for the slight falling off this year.

At the Spring Meeting amendments were adopted, the intent of which is to make the Associate grade no longer an intermediate grade between Member and Junior. These amendments appear in the report of the Constitution and By-Laws Committee.

STUDENT BRANCHES

The Council has been strict in its requirements for admission of Student Branches, and in general these are similar to those of the Carnegie Foundation for the Advancement of Teaching. There have been admitted to Student Membership since the last annual report, the University of Maine, Orono, Me., the University of Arkansas, Fayetteville, Ark., Yale University, New Haven, Conn., and Rensselaer Polytechnic Institute, Troy, N. Y.

PUBLIC RELATIONS COMMITTEE

An amendment to the Constitution was adopted at the Spring Meeting in Atlantic City which added the Public Relations Committee to the regular standing committees of the Society. The President appointed James M. Dodge, Past-President, Chairman, with associates, Robert W. Hunt, Past-President, Dugald C. Jackson, J. W. Lieb, Jr., Fred J. Miller. This committee will take up as one of its first duties the report of the committee appointed by the Council to investigate the proposed bill before the legislature of the state of New York looking to the licensing of engineers.

The special committee consisted of Chas. Whiting Baker, Chairman, Leonard Waldo and Alfred Brooks Fry, and their investigations have brought out considerable data on this in foreign countries.

PUBLICATIONS

Under the direction of the Publication Committee there have been issued twelve numbers of The Journal with approximately 2461 pages of text and 638 pages of advertising matter; and Volume 31 of the Transactions. The Year Book is now issued but once a year and combines the geographical and alphabetical lists formerly issued in January and July.

Fred R. Low has been appointed a member of the Publication Committee to serve the unexpired term of H. W. Spangler, resigned.

HOUSE COMMITTEE

The House Committee have completely the decorations of the rooms of the Society, including the Secretary's office. These improvements have received favorable comments from the members and others. The Society's rooms are now especially inviting and comfortable and offer a convenient place for making appointments.

LIBRARY

The Society has received 218 gifts of books during the year, 176 by purchase and 85 by exchange. By the coöperation of Founder Societies in the administration of the libraries of the three Founder Societies as one library and extending the benefits, it is hoped that in the near future a trained engineer and librarian may be engaged, looking also to possible coöperation with the New York Public Library when it moves to the new site near Society headquarters.

MEETINGS

Meetings of the Society are now being conducted in four cities. The Committee on Meetings having extended the privileges of the membership in Boston and St. Louis, have arranged for meetings of the Society in the cities of San Francisco and New York which shall be uniform with the first-mentioned cities.

During the past year there have been held 7 meetings in New York with an average attendance of 271; in St. Louis 6 meetings with an average attendance of 75; and in Boston 6 meetings, with an average attendance of 175, some in coöperation with other societies. At the inauguration of meetings in San Francisco the Committee on Meetings delegated the Secretary of the Society and Chairman of the Committee Meetings to be in attendance. Past-President Jesse M. Smith and the Secretary also attended a meeting in St. Louis during the year.

Two new committees have been appointed, one on meetings in New York, Walter Rautenstrauch, Chairman, Fredk. A. Waldron, Treasurer, F. H. Colvin, Edward Van Winkle and Roy V. Wright, thus not only making all meetings uniform but also giving the nucleus of an organization to take care of the social features of the regular annual meeting in New York. A Committee on Economic Administration of Industrial Establishments is being organized which shall have general responsibility for developing papers and meetings on that subject.

RESEARCH COMMITTEE

The Research Committee have prepared a list of laboratories of the various technical schools of the country. In addition to the name and location of laboratory, the data include the name of the director, the field of engineering for which the laboratory is equipped,

a list of subjects already investigated, the published reports, and a statement of problems under investigation. The Committee also has under consideration the development of a standard by which to judge the performance of safety valves.

STANDARD FLANGES

H. G. Stott, A. M. Mattice, J. P. Sparrow, and Wm. Schwanhausser have been appointed a committee to coöperate with the National Steam and Hot Water Fitters Association leading to the adoption of a uniform standard for flanged and screwed cast iron fittings.

IDENTIFICATION OF POWER HOUSE PIPING

The Committee, H. G. Stott, Chairman, H. P. Norton, Wm. H. Bryan, I. E. Moultrop, J. T. Whittlesey, appointed to report on the subject of standardizing the pipe coloring for power houses, advised the appointing of a special committee on the subject to establish at the earliest possible date a standard system of coloring. The same committee has been reappointed for this work.

LAND FUND COMMITTEE

On the resignation of the former Land Fund Committee, a new Committee was appointed by the Council, Worcester R. Warner, Chairman, C. N. Lauer, I. E. Moultrop, Geo. A. Orrok, F. H. Stillman. An active campaign has been started to clear the indebtedness of the Society for its share in the land on which the Engineering Societies Building rests, and $88,920.03 have been received to date, leaving $85,765.03 to be raised.

FINANCE COMMITTEE

The Finance Committee have taken an active oversight of the financial affairs of the Society and too much credit cannot be given for their conscientious work.

On account of the fact that election to membership occurs at a different date from that of the beginning of the fiscal year, at the request of the Council, the question of partial dues has been considered carefully, with the result that amendments have been adopted during the year and have become a working basis, as shown in the report of the Committee on Constitution and By-Laws.

CONSTITUTION AND BY-LAWS

Under the direction of the Committee on Constitution and By-Laws, the following amendments have been made to the Constitution, By-Laws and Rules:

C 10 An Associate shall be thirty years of age or over. He must have been so connected with some branch of engineering or science, or the arts, or industries, that the Council will consider him qualified to coöperate with engineers in the advancement of professional knowledge.

C 11 A Junior shall be twenty-one years of age or over. He must have had such engineering experience as will enable him to fill a responsible subordinate position in engineering work, or he must be a graduate of an engineering school. A person who is over thirty years of age shall not be eligible to membership in the Society as a Junior.

C 45 The Standing Committees of the Society to be appointed by the President shall be:

Finance Committee.
Committee on Meetings.
Publication Committee.
Membership Committee.
Library Committee.
House Committee.
Research Committee.
Public Relations Committee.

B 11 Each person elected to membership, except an Honorary Member, must subscribe to the Constitution, By-Laws, and Rules of the Society, and pay the initiation fee before he can receive a certificate of membership in the Society. Resignations from membership shall be presented to the Council for action.

B 16 The initiation fee and the annual dues for the first year shall be due and payable on the first day of the month following the date of the election of a Member, Associate or Junior. The annual dues for each ensuing year shall be due and payable in advance on the corresponding day in each year thereafter. Upon the payment of the initiation fee and the annual dues for the first year, the person elected shall be entitled to the rights and privileges of membership in the grade to which he was elected. The date of payment of a member's annual dues may be changed to the first day of any other month, and a pro rata adjustment of the dues made, by application to the Secretary.

B 17 A Member, Associate or Junior in arrears for dues for one year, on the first day of October previous to the Annual Meeting, shall not be entitled to vote, or to receive the Transactions or the publications issued by the Society thereafter until such dues have been paid. Should the arrears for dues or other-

wise be for more than two years, the name of such person shall be presented to the Council for such action as it deems advisable under C 24. Should the right to vote, or to receive the publications of the Society be questioned, the books of the Society shall be conclusive evidence.

B 18 The Council may, in its discretion, restore to membership any person dropped from the rolls for non-payment of dues, or otherwise, upon such terms and conditions as it may at the time deem best for the interests of the Society.

B 22 The Finance Committee shall consist of five Members or Associates. The term of office of one Member of the Committee shall expire at the end of each Annual Meeting. This Committee shall, under the direction of the Council, have a supervision of the financial affairs of the society, including the books of account. The Committee may cause the accounts of the Society to be audited and approved annually by a chartered or other competent public accountant. The Committee shall hold monthly meetings for the audit of bills and such other business as shall come before it and shall deliver to the Secretary for representation to the Council at the end of each fiscal year, a report of the financial condition of the Society for the past year, and also shall present therewith a detailed estimate for the probable income and expenditure of the Secretary for the following twelve months. It shall make recommendations to the Council as to investments, and when called upon by the Council, advise upon financial questions. It shall have charge of the making of all contracts and other obligations to pay money in the Society's work and the ordering of all expenditures thereunder.

B 24 The Publication Committee shall consist of five Members or Associates. The term of office of one Member shall expire at the end of each Annual Meeting. The Committee shall review all papers and discussions which have been presented at the meetings, and shall decide what papers and discussions, or parts of the same, shall be printed in the Transactions of the Society. The Committee shall have the supervision of the monthly publication of the Society known as "The Journal." The Committee will be expected to publish all such data as will be of assistance to engineers or investigators in their work. At the end of each fiscal year the Committee shall deliver to the Secretary for presentation to the Council a detailed report of its work.

B 37 The Annual Meeting shall begin in the City of New York on the first Tuesday in December and continue from day to day as the Council may direct.

The Annual Business Meeting of the Society shall be held on the Wednesday following the first Tuesday of December.

The Semi-Annual Meeting shall be held in such a place and begin on such a day as the Council may direct, and continue from day to day.

The Semi-Annual Business Meeting of the Society shall be held immediately preceding the first professional session of the Semi-Annual Meeting.

Professional meetings of the Society for the reading and discussion of papers and for topical discussions may be held at such times and places as the Council may direct.

Announcements of all meetings of the Society shall be published in The Journal.

A notice of each Annual and Semi-Annual Meeting and each Annual and Semi-Annual Business Meeting of the Society shall be mailed by the Secretary to each member in each grade not less than 30 days before the date of that meeting and at least 30 days before each Special Business Meeting.

R 24 Engineers and others not members of the American Society, but desiring to participate in the meeting of the Section, may enroll themselves as affiliates as heretofore provided with the approval of the Executive Committee of the Section. Such affiliates shall have the privilege of presenting papers and taking part in the discussions. They shall pay $5 per annum which shall be due and payable in advance, on October 1 of each year of their enrollment, and shall thereby be entitled to receive the regular issues of The Journal for a period covered by their dues.

R 29 The American Society of Mechanical Engineers will furnish monthly issues of The Journal to all members of affiliated organizations who are not members of The American Society of Mechanical Engineers upon the payment by each of two dollars per year, such payment being due January 1 of each year. The American Society of Mechanical Engineers will furnish gratis to each affiliated body, extra copies of advance papers for use at its meetings, the number furnished to be agreed upon at the discretion of the Secretary.

R 35 The tellers of election in counting the ballots for officers shall consider the ballot for an officer as valid, provided the intent of the voter as to that particular office is clear, even though his ballot as to candidates for another office may for any reason be invalid.

A special committee appointed to report on improvements in the methods of balloting now in use in the Society, Theodore Stebbins, Chairman, W. T. Donnelly and Chas. E. Lucke, have made a report which is to be considered at a joint meeting of the committees interested.

MEETING IN ENGLAND

The Secretary and Honorary Secretary presented reports of the enjoyable trip to England and the meeting with the Institution of Mechanical Engineers. The former report is in narrative form while the latter treats of the significance of international meetings.

The detailed reports of the Standing Committees are made a part of this report as they appear in The Journal for December.

THE NEWLY ELECTED OFFICERS FOR 1911

EDWARD DANIEL MEIER

PRESIDENT AM. SOC. M. E.

Edward Daniel Meier, president and chief engineer of the Heine Safety Boiler Company, was born in St. Louis, Mo., May 30, 1841. At the close of a scientific course at Washington University, St. Louis, in 1858, he studied for four years at the Royal Polytechnic College at Hanover, this being followed by an apprenticeship at Mason's Locomotive Works at Taunton, N. J. At the outbreak of the Civil War he enlisted in the Grey Reserves, the Thirty-second Pennsylvania, and served in the army of the Potomac until after the Battle of Gettysburg. He subsequently served in the Second Massachusetts Battery, also in the United States Engineer Corps, and finally became lieutenant in the First Louisiana Cavalry, seeing much active service and on May 30, 1865, receiving the surrender of Lieutenant-General John B. Hood and staff.

At the close of the war he entered the Rogers Locomotive Works at Paterson, N. J., remaining one year. From 1867 to 1870 he was associated with the Kansas Pacific Railway, first as assistant superintendent and then as superintendent of machinery, leaving there to become chief engineer of the Illinois Patent Coke Company. In 1872 he became manager of the Meier Iron Company, building its blast furnaces, and from 1873 to 1875 directed the machinery department of the St. Louis Interstate Fair. During this time he became actively interested in the St. Louis cotton industry and designed machinery for baling cotton, first with the St. Louis Cotton Factory and then with the Peper Hydraulic Cotton Press. In 1884 he organized the Heine Safety Boiler Company for the development in the United States of the water-tube boiler of that name, and has been its president and chief engineer ever since. He was also responsible for the introduction of the Diesel motor into the United States and until 1908 was engineer-in-chief and treasurer of the American Diesel Engine Company.

Colonel Meier was lieutenant-colonel and later colonel of the First Regiment of the Missouri National Guard serving about ten

years, and is a member of the Grand Army of the Republic and of the Loyal Legion. He has been active in a number of professional organizations, serving in 1881–1884 as treasurer of the St. Louis Engineers Club, in 1889–1890 as its president and also as secretary of the American Boiler Manufacturers Association, and in 1908–9 as president of the latter society and of the Machinery and Metal Trades Association.

In the Society he has been active on many committees, was one of the managers from 1895 to 1898, and has twice been elected vice-president, serving his first term from 1898 to 1900, and beginning the second in 1910, an office which he still held at the time of his election as president.

VICE-PRESIDENTS

GEORGE M. BRILL

George M. Brill was born at Poughquag, N. Y., in 1866. He prepared for college at Wesleyan Academy, Wilbraham, Mass., and entered Cornell University where, after covering the mechanical and electrical engineering courses, he was graduated with the degree of M.E. in 1891. In 1895 Mr. Brill also received the degree of M.M.E. He was at once employed by the Solvay Process Company, Syracuse, N. Y., as engineer of tests and for nearly five years was engaged in research work. In 1896 and 1897, he was engineer in charge of the construction of their plant at Detroit, resigning to accept the position of assistant manager of the construction and mechanical departments of Swift and Company. Early in 1900 he engaged in a general engineering practice, specializing in the complete engineering of manufacturing and power plants. A large number of important examinations and investigations have been made for financial and industrial purposes.

About a year ago a partnership was formed with H. C. Gardner, Mem.Soc.M.E., manager of the construction and mechanical departments of Swift and Company, under the name of Brill and Gardner.

For several years Mr. Brill has been retained as consulting engineer for the Solvay Process Company.

He is chairman of the Advisory Board of Engineers to coöperate with the smoke department of the City of Chicago.

Mr. Brill became a Junior member in 1891 and a Member in 1896 and was a member of the Council as Manager from 1904 to 1907. In addition, he is a member of the American Institute of Electrical

Engineers, Western Society of Engineers, American Association for the advancement of Science, American Society for the Promotion of Engineering Education, Union League Club of Chicago and Columbia Club of Indianapolis.

EDWIN M. HERR

Edwin M. Herr was born in Lancaster, Pa., May 3, 1860, and removed with his parents to Denver, Colo., in 1873, where he attended the public schools, leaving high school before graduation to work as a telegraph operator, first with the Western Union Telegraph Company, and later on with various railroads centering in Denver. In 1881 he entered the Sheffield Scientific School at Yale University and pursued the course in mechanical engineering, graduating in 1884 with the degree of Ph.B. He then served an apprenticeship as a machinist, first at the Altoona Shops of the Pennsylvania Railroad, and afterwards at the Milwaukee Shops of the Chicago, Milwaukee and St. Paul Railroad, after which he accepted a position as draftsman in the mechanical engineer's office of the Chicago, Burlington and Quincy Railroad. He later became successively engineer of tests, superintendent of telegraph and division superintendent of the Chicago, Burlington and Quincy, resigning the position of superintendent of the Galesburg Division of that road in 1890 to take the position of master mechanic of the Chicago, Milwaukee and St. Paul Railroad in charge of the shops at Milwaukee and the power and rolling stock east of the Mississippi River. In 1892 he was appointed general superintendent of the Grant Locomotive Works at Chicago and in 1894 made two trips to Europe on general engineering investigations relating largely to the building of locomotive works in Russia. He was at this time also connected with the Gibb's Electric Company at Milwaukee and later assistant superintendent of Motive Power of the Chicago and North Western at Chicago and Superintendent of Motive Power of the Northern Pacific Road at St. Paul.

In 1898 Mr. Herr came to Pittsburg as assistant general manager of the Westinghouse Air Brake Company, afterwards becoming vice-president and general manager, and in 1905 was elected first vice-president of the Westinghouse Electric and Manufacturing Company, his present position.

HENRY HAGUE VAUGHAN

Henry Hague Vaughan was born December 28, 1868, at Forest Hill, Kent, England, and was educated at Forest Hill School, Woodford, Essex. From 1885 to 1887 he attended the Applied Science Department, Kings College, London. In 1888 he became an apprentice at Nasmyth, Wilson and Company's Works, Patricroft, Lancashire, England, where he remained until 1890. The following year he was employed as a fitter with the M. S. & L. Railway at Gorton, Lancashire, and with the L. & S. W. Railway at Nine Elms, Middlesex. Later he became associated as machinist, draftsman and assistant engineer of tests and as mechanical engineer with the Great Northern Railway, St. Paul, Minn. He resigned in 1898 and became mechanical engineer with the P. & R. Railway at Reading, Pa., leaving there in 1899 to act in the same capacity for the Q. & C. Co., Chicago, Ill. In 1902 he became assistant superintendent of motive power with the L. S. & M. S. Railway, Cleveland, Ohio; and from 1904 to 1905, superintendent of motive power with the Canadian Pacific Railway, Montreal. Since that time he has been assistant to the Vice-President with the same company.

MANAGERS

DAVID FRANCIS CRAWFORD

David Francis Crawford was born in Pittsburg, Pa., December 4, 1864, and was educated in the public schools and in the Pennsylvania Military Academy.

In 1885 Mr. Crawford was apprenticed in the Altoona Shops of the Pennsylvania Railroad and from that time has been connected with the Pennsylvania Lines. In 1889 he was made inspector of the Test Department and from 1892–1895 he was master mechanic of the Ft. Wayne Shops. From 1895–1899 he was assistant to the superintendent of motive power of the Northwest System and from 1899–1903 superintendent of motive power, and from 1903 to date he has been general superintendent of motive power of the Pennsylvania Lines.

Besides being a Member of this Society, Mr. Crawford is a member of the American Institute of Electrical Engineers, the Master Car Builders' Association and the American Railway Master Mechanics

Association. He was sent as a reporter and delegate to the International Railway Congress at Berne, in 1910.

STANLEY G. FLAGG, JR.

Stanley G. Flagg, Jr., was born in Philadelphia, January 21, 1860, and was educated in a private school and in the Philadelphia High School.

In this same year he entered his father's works, Stanley G. Flagg and Company, as an apprentice, working through each mechanical department up to the successive positions of foreman, shop superintendent, foundry superintendent and junior partner. In 1909 he took over the sole ownership of the business.

Mr. Flagg is a member of the American Institute of Mining Engineers, the American Foundry Association, the American Society of Testing Materials, the British Iron and Steel Institute, the Staffordshire Iron and Steel Institute and other allied associations.

EDWIN BRITTON KATTE

Edwin Britton Katte was born in St. Louis, Mo., October 16, 1871. In 1881 he entered the Cutler School in New York City and eight years later Sibley College, Cornell University, from where he was graduated in June 1894, with the degree of M.E. During the summer of 1893 Mr. Katte traveled abroad, studying electro-hydraulic plants. Returning to Cornell University, he took up special work in the design of vertical marine type engines and in mechanical and electrical testing, and received the degree of M.M.E. in 1894. He then entered the establishment of Henry R. Worthington, where he began as a mechanic's helper, later passing to the testing department, and finally becoming a foreman in charge of erection. In the early part of 1896 he became assistant engineer in charge of the erection of the superstructure of the Park Avenue viaduct of the New York Central and Hudson River Railroad Company. Two years later he was placed in the drafting room in the chief engineer's department whence he was later advanced to the position of assistant engineer in charge of water supply, and in 1898 was appointed mechanical engineer in charge of the design and construction of heat, light and power plants, coaling stations and water supply. In December 1902 Mr. Katte was appointed electrical engineer and secretary of the Electric Trac-

tion Commission of the New York Central and Hudson River Railroad Company, under whose direction he had immediate charge of the electrical and mechanical engineering corps engaged upon the work of electrification of the various lines of that company in New York City and its vicinity.

Mr. Katte is also a member of the American Institute of Electrical Engineers.

NECROLOGY

WILLIAM HENRY BRYAN

William Henry Bryan died December 5, 1910, at Chicago, Ill. He was born August 14, 1859, at Washington, Mo., and received his early education at the country schools. In 1881 he was graduated from Washington University with the degree of M.E., having spent his vacation in the shops of the Missouri Pacific Railroad where he learned telegraphy and other railroad practices. Since that time he had been employed as a general assistant erecting engineer and salesman with Frank H. Pond; as local manager of the George F. Blake Co., as secretary of the Pond Engineering Company; and in 1889 as secretary and local manager of the Heisler Electric Light Company of St. Louis, Mo., then developing a long-distance series of incandescent lighting. In 1891 he went to Chicago as manager of the Western branch of the Yale and Towne Company. Since 1892 he had been a consulting mechanical and electrical engineer in St. Louis. During this period he constructed the water works at Washington, Mo., the power plants of the Imperial Light, Heat and Power Company, of the Coliseum, of the Grand Leader, of the Eli Walker Building, and of Ferguson and McKinney, St. Louis. He also rendered excellent service in practical smoke abatement for the Citizens' Association of St. Louis in 1892 and 1893.

Mr. Bryan was a member of the Engineers' Club of St. Louis, having served as secretary, vice-president and president; of the present Smoke Abatement Committee of the Civic League of St. Louis; of the American Society of Heating and Ventilating Engineers; of the St. Louis Railroad Club, the Mercantile Club, the American Water Works Association, serving on its Committee of Depreciation, and president of the Washington University Association. He became a member of the Society in 1891, and since 1906 had been an active and influential member of the Committee on Meetings, and as such was mainly instrumental in inaugurating and conducting a system of local meetings in St. Louis.

LEWIS JOHNSON

Lewis Johnson, one of the oldest members of the Society, was born in New Orleans, La., June 8, 1836, and was educated in private schools. Following a natural tendency for mechanics he entered the mechanical profession while very young and served both at shop practice and marine engineering. His education was gained by close and earnest study and by a wide experience which included, among other things, the designing and constructing of new machinery for the baling of cotton, ginning of moss, manufacture of ice, and propulsion of steamers. During the last few years of his useful life, Mr. Johnson was president and chairman of the Executive Committee of the Sewerage and Water Board of New Orleans, and of the Audubon Park Association, both directed toward civic improvement. At the time of his death, May 26, 1910, he was president of the Johnson Iron Works of New Orleans.

GEORGE HENRY BAUSH

George Henry Baush, Member of the Society, was born in Holyoke, Mass., April 9, 1870, and was educated in the public schools of that city. His technical training was gained from his father, who founded what is now known as the Baush Machine Tool Company, of Springfield, Mass. In 1896 he became general foreman and superintendent of the Baush Company and in 1904 was elected its vice-president and general superintendent, all designing of machine tools being entirely under his charge. In 1906 Mr. Baush became associated with Hill, Clark and Company, as manager of their Philadelphia office, resigning from this position to accept a similar one with the Fay Machine Tool Company of Philadelphia, which he retained until within a few months before his death on September 12, 1910.

SAMUEL EVANS STOKES

Samuel Evans Stokes, the son of Dr. John H. Stokes, was born at Moorestown, N. J., on October 3, 1846, and died at his home in Germantown, Philadelphia, on November 12, 1910. He was graduated from the Lawrenceville school in 1863 and immediately went into the machine works of Isaac P. Morris and Company in Philadelphia. Here he remained for four years, going from one department to another and becoming an expert machinist and draftsman. After

two years spent in large works in Detroit he formed a partnership with Alfred Parish, known as the Stokes and Parish Machine Works. In 1876 this firm obtained the concession for all the machinery required by the Centennial Commission and the exhibitors and were given entire charge of Machinery Hall and the erecting of exhibits, also building a steam elevator which ran from the main hall to the roof. Shortly afterward the firm began to build hydraulic elevators, which soon became their specialty.

In 1885 a serious nervous breakdown made it necessary for Mr. Stokes to retire from active business, and the firm was taken over by the Otis Elevator Company of New York. In 1896 Mr. Stokes went abroad with his family, remaining in Europe for two years.

OLIVER S. SHANTZ

Oliver S. Shantz was born at Breslau, Ontario, Can., August 12, 1863, and received his early education at the Berlin and Ithaca high schools. From 1879 to 1886 he was apprenticed to J. Y. Shantz and Sons, Berlin, Ontario, manufacturers of automatic machinery. In 1893 Mr. Shantz was graduated from Sibley College, Cornell University, with the degree of M.E. and six years later received a master's degree in mechanical engineering from the same university. He was successively engaged as engineer and designer for Schaeffer and Budenberg for one year; as instructor in mechanical engineering at Cornell University for four years; as draftsman for the Otis Elevator Company; salesman for the Tonkin Boiler Company, New York and assistant engineer with the Edison Portland Cement Company. In 1901 Mr. Shantz affiliated himself with the Rand Drill Company, representing them in Chicago, and while with this company made a speciality of sand pumping, installing many large plants of this character. In 1905 the Rand Company was merged into the Ingersoll-Rand Company of New York and Mr. Shantz took charge of their interests in Detroit. Four years later he re-entered the employ of J. Y. Shantz and Son Company, Buffalo, N. Y., manufacturers of buttons, in the capacity of assistant manager.

Mr. Shantz died on September 7, 1910, after an illness of a few days. He was a member of the Society, the Manufacturer's Club and the Chamber of Commerce, Buffalo.

THE CONTINUATION SCHOOLS OF MUNICH

By Dr. Georg Kerschensteiner[1]

Director of Education, Munich

When I became director of education, it was evident to me that our educational institutions, and especially those concerned with the mass of the people, support neither industry nor state. In Germany over half a million children leave our elementary schools every year at the age of fourteen, the very age at which character begins to form and guidance is most necessary.

When the primary school was established at the beginning of the nineteenth century, seven or eight years of attendance sufficed. At that time Germany was not a thickly populated country, custom held sway in trade, and tradition in the family, both in rural districts and in the towns. Today the German State is an over-populated industrial community in which custom is disappearing and unfettered individualism seeks to overturn tradition, in which half of the rising generation receives neither the discipline of a well-ordered family life nor a training in the duties and obligations that will rest on them as citizens. Between 1860 and 1875 the German State acknowledged that the existing elementary schools were insufficient to impart necessary education, and the public continuation school arose. At Munich, for instance, two types of this school were founded in 1875, one for apprentices and the other for journeymen and foremen. The first was a general school of three standards, with from five to eight hours of instruction per week, compulsory for all boys in Munich between the ages of thirteen and sixteen and was organized as an extension of the so-called general education of the elementary school. No regard whatever was paid to the pupil's trade. Instruction was given for five hours on Saturday and for three hours on one after-

[1] Address given under the auspices of the National Society for the Promotion of Industrial Education, with The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers coöperating, in the Auditorium of the Engineering Societies Building, Thursday evening, December 8, 1910.

noon during the week, the subjects being reading, writing, arithmetic and drawing. At the continuation school for journeymen, attendance was optional and the subjects of instruction were drawing, painting, modelling and chasing. Attention was paid almost exclusively to draftsmanship and the hobby of drawing was ridden to death. The school never thought of giving instruction in the management of a cost book, the preparation of specifications, or in bookkeeping. It totally ignored the fact that while the economic conditions of the present day require a technical and commercial training from the worker, the social conditions imperatively demand for him a civic training. Instead of realizing these requirements, the school too often misdirected the pupil, making a moderate artist out of a good decorator and a second-rate furniture designer out of a good joiner, an engineer out of a watchmaker.

Similar institutions arose in other German towns, at first arranged for voluntary and later for compulsory attendance. But while the voluntary continuation school got thousands of pupils who were totally uneducated for their life-struggle, the general compulsory school was regarded by its pupils with indifference. The employer looked on it as a burden and the pupil considered it a waste of trouble. All concerned were glad when attendance ceased and few of the apprentices ever thought of making use of the opportunities offered by the day or evening trade schools.

The barrenness of these schools became notorious. During the last decade of the past century the general continuation schools for boys were replaced by trade continuation schools modelled on those of Leipzig, Vienna and the Grand Duchy of Baden. This was a great step forward. Apprentices from the same trades could now be enrolled in the same classes and it was possible to adapt the curriculum to the actual needs of the pupil. Nevertheless, the problem of the continuation school seemed to me to be still unsolved. The more I studied these schools during my journeys of inquiry in Germany, Switzerland and France, the more clearly did I see their incompleteness. The instruction was given, as a rule, in the evening when both the pupils and the teachers were worn out. Though the school endeavored to make the pupil's trade the focus of interest, yet the instruction lacked the breath of life. A few individual employers, and here and there an association of employers, took a languid interest in it. The bond of union between the school and the workshop was still wanting. The boy got, it is true, training in the requirements of his trade, but no one laid emphasis on the most important side,

the practical work. Above all, it was forgotten that the boy was intended to become not only a good worker but also a good citizen, that the man was not to disappear in the laborer nor the future citizen in the apprentice. It was forgotten that modern states have placed power in the hands of the people, that the laziest and roughest day laborer has an equal voice with the cultured statesman and the philosopher in the government of his country, and therefore, that the most capable of our working classes ought to get a thorough insight into their duties as citizens. In a word, it was forgotten that civics is at least as necessary an element in the syllabus of our continuation schools as are drawing and arithmetic. Therefore, I recommended not only to my city, but also to the Prussian Royal Academy, a wholly new organization.

During the several times I have been in Scotland, England and the United States, I have seen that these nations keep the true import of this great task well in view. In that excellent book by Professor Sadler, Continuation Schools in England and Elsewhere, I find a quotation from circular No. 374 of the Scotch Education Department to this effect: "School work has for its aim and end objects more important than preparation, in the narrow sense, for any particular occupation. It should aim at producing the useful citizen imbued with the sense of responsibility and of obligation towards the society in which he lives: it should render him, so far as the school can do so, fit in body and alert in mind and should prepare him for the rational enjoyment of his leisure time as well as fit him for earning his living." In truth, that is the end and aim of all schoolwork and especially of the work of the continuation schools. How then is it to be attained? On what principles are the continuation schools to be organized, so that they may give a boy not merely instruction in his trade but also an education in citizenship? Time will not permit me to enlarge on the arguments that influenced us in Munich, but while I describe what we have done I shall be able to touch incidentally on our motives.

The first step was to connect the craft school and practical instruction with all trade continuation schools. Thousands of boys have only a one-sided apprenticeship and thousands more lack even this. We must inspire them with the joy that springs from thoroughness of work. They must learn to appreciate the moral effect of good work on their own personalities. If we put the craft school and practical training, instead of textbooks and mere words in the forefront of instruction, we gain the good-will of the pupils at once. This being

so, there is no difficulty in leading them to appreciate allied branches of school work, such as drawing, arithmetic, bookkeeping, technology and the knowledge of materials, tools and machines. The interest aroused by practical work will be transmitted to all these allied subjects.

Through considerations of this kind, I was strongly convinced that a carefully devised scheme of manual instruction ought to form part of the curricula in the highest classes of the elementary school, and that this should be done in the interests both of general education and of any particular trade that the pupil may join after leaving school.

The second point was to enlist the active sympathy of the different associations of employers. Here we were assisted from the outset by our own school workshop. For the employers, seeing that apprentices took an increased interest in their work and finding them more efficient, gave our teaching the credit. In order to gain the support of the associations we permit them to inspect our schools, to advise us regarding their progress and to assist us in the choice of foremen and journeymen as teachers. We also consult their wishes as to the time table and invite their opinion on the syllabus of instruction. In return for these opportunities, we expect them to supply models, tools and machinery and also, within reason, to provide raw materials, to make attendance possible during more suitable hours of the day, and to put pressure on apprentices to attend the regular classes.

In this manner we have combined rights and duties, privilege and obligation. And we have found that the more the employers use the opportunities we have given, the more ready they are to make sacrifices for the schools; and that the more they come to appreciate the value of the work being done in the schools, the more conscious they become of community of interests.

The trade continuation schools being thus fairly started with the good-will of the employers' associations, it was possible to attack the third group of difficulties, the time table. So far as quantity is concerned, we demand from eight to ten hours per week according to the trade. In addition, we arrange voluntary classes or special courses for further practical training and for gymnastics. So far as the hours of instruction are concerned, we have decided to give no instruction on Sunday and to arrange no compulsory attendance in the evenings after workshops are shut. As a rule we demand at least two afternoons per week from 2 o'clock to 7, or one afternoon

and one morning, or one whole working day. We have trade continuation schools where the apprentices come at 7 in the morning and remain till 6 in the evening. The associations of employers have shown themselves ready to give us an increased amount of time and the more the employers become aware of the advantage of the school, the more willing they are to comply with our requirements. In return, we pay attention to the social and economic conditions of every single trade. We use the dull season more for instruction than the busy time and we can always arrange short courses for workmen temporarily out of employment. Builders and decorators receive twelve hours of instruction from 5 p.m. to 7 p.m. every week from October 15 till March 15. For the rest of the year they get three hours on a week day. Other trades get ten hours per week for eight months of the year instead of nine hours per week for the full term of ten months. Thus the goldsmiths and the confectioners get December as a school holiday and the hairdressers are free during the carnival time. In all cases the organization is the result of an understanding with the representatives of the trade concerned. But, however varied the details, there is a general agreement on the main principle: that every apprentice must attend the continuation school during the whole time of apprenticeship or until the completion of his eighteenth year.

These three features of the new organization have inspired the school with vigorous life. Never in the course of my existence, has it become so evident to me that a rational education produces marvellous effects, not only in the pupils but also in the employers, and that with the delight of successful work the harsh selfishness of the individual is disappearing; that the need for the formation of a single great community is realized; and that the hope of a good harvest strengthens the readiness for sacrifice.

The growth of common interests has been as noticeable among apprentices as among employers. The man at the next bench has become a comrade partaking of the same pursuits and a critic worthy of attention. The teacher is no longer a stranger but a foreman or journeyman of the pupil's own trade with whom he may have to coöperate later, whose rival he may possibly become, one who, nevertheless, is endeavoring to develop in his juniors the qualities which will make them worthy successors. The red-tape of educational authority and the suspicious visits of the attendance officer disappear. The pupil is conscious of the support of the employers' association, whose personal sympathy and unselfish care soon enlist

his support in its favor. Thus it is, you will readily understand, that *esprit de corps* flourishes apace under these fortunate conditions and promises to yield us in riper years that larger sense of public spirit which we call love of our native land.

Thus is the ground being prepared for our fourth and main task, the inculcation of civic responsibility. By this I mean the recognition of the relations between the interests of the individual and those of the community and a just appreciation of the tasks the state has to fulfil. When the boy's soul has been aroused by the practical work of the school, there is no longer any difficulty in rendering his mind susceptible to this training. The interest he takes in his trade is increased when he comes to study the history of his trade. But the history of his trade is necessarily connected with the history of mankind in general. By observing the rise and decay of his vocation in the course of ages, he is introduced to the complicated conditions of the present day. The historical method which reveals step by step the mutual dependence of all sections of humanity, which traces the deep-seated relationship of vocations, people and states, teaches the pupil the necessary limits of self-interest and the obligations that membership in a state imposes on him. A great number of trade schools find here a vast field of exploration. Consider the history of such important trades as the goldsmiths and the builders; consider the textile industries, the mechanical industries and the oldest of all industries, agriculture. What a wealth of illustration their history affords us! All this instruction must, of course, be of an elementary kind and based on illustration by concrete example. By giving one hour per week for three or four years to this instruction we manage to get most of our pupils to understand the functions of our economic, social and political institutions. They come to consider not only their personal position and the position of their trade, but their views expand to a consideration, first of their native country and then of the complicated conditions of international intercourse. Thus they slowly learn the truth of the maximum that the meaning of life is not to rule but to render service, service to one's neighbor, service to one's town, service to one's native country, service to truth and justice.

Our pupils ought not only to learn what it means to be a citizen, they must also learn to act as good citizens. For this reason we seek to introduce some kind of self-government into our continuation schools so that the pupils may undertake something for the good of the school and of their comrades. The well-organized school affords

us plenty of opportunities, which have for a long time been utilized in the best British and American schools, but so far we have neglected them in Germany.

The essential features of the compulsory trade continuation schools of Munich are thus summed up in these four points: (*a*) practical work is made the center of interest; (*b*) the active sympathy and coöperation of employers on the one hand, and of trade societies and guilds on the other, is enlisted on behalf of the schools; (*c*) the time of instruction is sufficient in amount and excellent in quality; (*d*) every opportunity that presents itself for training the citizen is utilized.

So far I have spoken of the trade continuation schools. In addition to them, we have 12 local continuation schools in which boys are enrolled who are not yet apprentices, but who are engaged in casual and unskilled labor or who cannot be provided with a special continuation school because their numbers are too few. But while in the trade continuation schools the instruction includes German literature, commercial correspondence, commercial arithmetic, bookkeeping, knowledge of tools, machinery and materials, civics and hygiene, technical drawing and practical work, religion and, if required, physics, chemistry and gymnastics, the instruction in the local continuation schools bears a more general character, laying stress on practical work, gymnastics, hygiene and civics. In both types of school, the development of responsibility and initiative is encouraged. The trade continuation schools have their own buildings, of which I will show you views later, but the local continuation schools have been housed in primary schools and placed under the supervision of the headmasters of these schools.

During the present year we have in all, about 9400 boys between the ages of 14 and 18, and 2700 journeymen as pupils. In the year 1911, when the original class of apprentices will have completed the full course, we expect to have 10,000 boys and about 3600 journeymen enrolled in these schools.

The organization of the trade continuation schools will be best explained by considering the engineers' school. This is open to all apprentices in engineering, electrical and instrument-making works. It has four consecutive grades each representing a year of school life. The school meets for nine hours per week. The teaching is taken on week days, either in the mornings or in the afternoons, but never later than 7 p.m. Those apprentices who wish to get more practical work may attend optional continuation classes from 7 to 9 p.m. If

an apprentice does not make satisfactory progress he may be required to repeat attendance at a class for a whole term. The engineers' school has at present from 500 to 600 apprentices who are taught in about 24 classes. Instruction is given either by skilled workmen, that is, foremen or journeymen, or by trained teachers from our primary and higher public schools. The appointments are either as permanent or as visiting teachers. One condition is rigidly observed: all workshop instruction is given by a master or journeyman. Great care is taken in the preparation of the teachers for their task. On this point I must ask you to refer to Mr. Stockton's article in Mr. Sadler's book, as I have still an important section to deal with at some length, the continuation school for girls.

We have two kinds of continuation schools for girls, an optional school and a compulsory one.

The compulsory school is organized in three standards, each representing a year of school life, with three hours of attendance per week, for girls between the ages of 13 and 16. For girls who can spare more time there is also an optional continuation school with from six to ten hours of instruction per week. In both cases all instruction is given before 6 p.m. and, as in the boys school, no fees are charged.

To educate the rank and file of the people in this manner—the boys from 14 to 18 years and the girls from 13 to 16—is naturally expensive, and more expensive for boys than for girls. But the continuation schools are not so expensive as the primary schools. The average cost of the primary pupil is $24 per annum, while in the compulsory continuation school for boys it is $18 per annum. During the present year our primary schools with 70,000 pupils cost $1,700,000; the boys' continuation schools, with 9400 pupils, cost $300,000, and the continuation school for girls with 10,500 pupils, cost $70,000.

These schools exist at present in this perfection only in Munich. I have already said that Würtemberg has adopted the same organization for the whole country, that similar institutions are to be found in Baden, that the canton of Zurich in Switzerland has quite recently promulgated a new continuation-school law which in many respects resembles its Munich predecessor, and that, finally, the city of Vienna has erected at enormous cost a central building for apprentices' continuation schools, the framework of which is exactly the same as in Munich. Thus you see that South Germany, Austria and German Switzerland have started on the road of Munich's continuation-

school organization. In north Germany, the greatest energy is being expended, too, on the problem of compulsory continuation schools, but at present without any attempt to base the organization on the school workshop.

The reason for this must not only be sought in the fact that pedagogical opinion in Germany is still very strongly permeated with the idea of so-called general culture, but also in the difference between the south German and the north German employer. The latter is mostly an ardent opponent of the school workshop. Another reason is, perhaps, the difficulty with which organizers and school men make up their minds to accept the innovations of a colleague. It is a fundamental characteristic of human nature that everyone who has a question to solve likes to contribute his own share to the solution. There is a German riddle that illustrates what I mean: "What is the difference between God and a German Professor?" and the answer is, "God knows everything, and the German professor knows everything better." This knowing better is always a hindrance towards the quick realization of a good thing. I do not wish to throw a stone at anybody, for we all can make the same observation about ourselves. We are all inclined to know things better than our colleagues. When we have worked ourselves into a special hobby, consistently and energetically for many years, it is unspeakably difficult so to enter into the ideas of another man who does not agree with us, that we can do him justice on all sides. Nevertheless, experience will show in the case in question that the purely theoretical continuation school which entirely avoids practical teaching, will not fulfil its purpose. In your country, it is hardly probable that this experience will be necessary. You have already excellent school workshops of various kinds, the value of which for the education of the man, as opposed to the workman, has been brilliantly demonstrated in the publications of the National Society for Promotion of Industrial Education. The essential reason why the continuation school should not become a purely theoretical school is that its limitation to theoretical instruction would form an almost insuperable barrier to transforming our schools into educational institutions for community life. The transformation of schools into institutions of this kind, or, as I prefer to express it, into communities of labor, is the fundamental problem of all school organization. Its solution is the task of the present century. So long as our schools of all kinds, not the continuation schools alone, are not organized as communities of labor, they will not prepare their scholars as they should for the great labor

community that surrounds us—the state. I can give no better illustration of what I mean than in a quotation from your excellent countryman, Prof. John Dewey, in his Moral Principles of Education.

> I am told that there is a swimming school in a certain city where youths are taught to swim without going into the water, being repeatedly drilled in the various movements which are necessary for swimming. When one of the young men so trained was asked what he did when he got into the water, he laconically replied, "Sunk." The story happens to be true; were it not, it would seem to be a fable made expressly for the purpose of typifying the ethical relationship of school to society. The school cannot be a preparation for social life, excepting as it reproduces, within itself, typical conditions of social life.

All our present schools are such swimming schools on dry land as far as social education is concerned. We may give our pupils a vast amount of instruction as to their relation to state and society. But we do not accustom them to regard their work from this point of view, and give them no opportunity of making practical use of their knowledge in the service of their fellow pupils. Our schools are therefore not schools for social service. But nothing could be better adapted for this purpose than the continuation schools I have described, in so far as they are intimately combined with workshops and laboratories. For there is no place more suitable for uniting scholars for community of labor than workshops, laboratories and experimental gardens.

The only path to real state community of labor is to accustom the rising generation from its earliest year to place its work not only in its own personal service, but also in the service of its youthful companions. Only thus can we hope to develop the two great fundamental virtues of devotion to aims outside ourselves, and of consideration for the interests of others. And only thus will it, in all probability, be possible to preserve our great modern constitutional states from the dangers that threaten them through their own industrial, economic, social and political development.

PRESIDENTIAL ADDRESS

By George Westinghouse, Pittsburgh, Pa.

President of the Society, 1910

A year ago I was honored by my election to the presidency of The American Society of Mechanical Engineers. In accepting office, I expressed an apprehension that other duties of an onerous character might prevent a fulfillment of your reasonable expectations, and I fear that when all is summed up, you will agree that such an apprehension was well founded. I desire at once to express a sense of my obligations to my associates for their helpfulness and consideration in aiding me partly to discharge my duties. Although my time for the Society's work has been very limited, I have had many occasions to observe how efficiently the splendid organization which controls your affairs has performed the various duties involved in the development and management of an engineering society.

The chief event of the year was the Joint Meeting of the Institution of Mechanical Engineers with our Society in Birmingham and London. From all sides have come evidences of the success of those meetings and of the great benefit of their deliberations to engineering. The welcome extended by our brother society to those of our Society who were present exceeded in cordiality and completeness the expectations of those who knew that there would be a warm and full-handed reception, and nothing was lacking in the perfection of arrangements for the meetings and for the comfort and pleasure of our members and their ladies.

In these days, the effects of such international meetings and interchanges of good-will cannot fail to be lasting, especially in promoting those relations which stand for the advancement of science and commerce, as well as those broader international relationships which tend towards the conservation of peace between all countries.

Presented at the Annual Meeting of The American Society of Mechanical Engineers, December 1910.

O.K.

Of almost equal importance was the joint meeting of members of the engineering societies held in Boston on January 21, which had been brought about by a member of our Society, Professor Hollis, of Harvard University. On this occasion about four hundred members of the engineering societies were present, including eight presidents of engineering societies or institutions, besides prominent members of many others, including architectural and scientific societies closely identified with the work of engineers.

Under the well-defined policy of your Council and officials, the members of our Society in Boston, St. Louis and San Francisco have been encouraged to hold important local meetings, and in this manner to bring the widely scattered members of the Society into more intimate relations with each other and with our affairs in general, and it is the purpose to extend our efforts in this direction as rapidly as circumstances may indicate.

My contributions to the discussions of matters of interest to our Society have been a short address, appropriate to the occasion, at the joint meeting of engineers in Boston, in which I laid stress upon the desirability of establishing, by coöperation between all engineering societies, such general standards in the construction of electrical and mechanical apparatus as would tend to reduce cost, increase efficiency, and lessen our difficulties.

In a more carefully prepared address, presented at the Joint Meeting in England, I urged the importance of an early decision on the part of those interested as to uniformity in the essential features involved in the electrification of railways. The discussion of this paper emphasized the necessity for early action on the recommendations made in regard to the selection of standards to meet the very few essential requirements.

As often happens in the discussion of a complex problem, some of the speakers misinterpreted my address and concluded that the paper specifically recommended the adoption of one particular system out of several well-known systems as a universal standard, whereas my specific recommendations were stated as follows:

"The additional fundamental requirements for electrically operated railways are:

(*f*) A supply of electricity of uniform quality as to voltage and periodicity.

(*g*) Conductors to convey this electricity so uniformly located with reference to the rails that, without change of any kind, an electrically fitted locomotive or car of any com-

pany can collect its supply of current when upon the lines of other companies.

(*h*) Uniform apparatus for control of electric supply whereby two or more electrically fitted locomotives or cars from different lines can be operated together from one locomotive or car.

"Outside of economy in capital expenditure and economy and convenience in operation by steam or electricity, it matters not whether each locomotive and car and the apparatus upon them differ from every other locomotive and car in size or details of construction, so long as the constructions are operative and the materials employed are used within safe limits."

The selection of a system embodying these fundamental requirements would leave to manufacturers and inventors the same latitude for development and improvement in the construction of railway electrical machinery as has always existed with reference to steam-operated railways, where the fundamental requirements were: a standard gage of track, standard couplings of cars, and standard braking and signalling apparatus. To appreciate this observation, one has only to contrast the locomotive of twenty years ago with the mammoth Mallet compound locomotives which are now being introduced, or the freight car of ten tons capacity with the modern steel car of fifty tons capacity.

I cannot impress too strongly upon the members of this Society the great importance of lending their aid to bring about such an early decision in regard to the standards to be adopted in the electrification of railways as will insure to the traveling public the benefit of this method of transportation at the earliest possible moment and on an advantageous basis to the railways, which will be required, even under the most favorable circumstances, to expend vast sums of money in changing from steam to electric operation.

It has been suggested to me that it would interest the members of the Society to have a short account of the conception and development of the air-brake, to form an authoritative statement for the records of the Society, and as I believe I am chiefly indebted to my work in developing the air brake and introducing it upon railways for the honors you have conferred upon me, I have pleasure in complying with such suggestion, especially as a statement of the conception and development of the air brake will supplement what I have heretofore said in regard to the benefits to be derived from the standardization of mechanical devices.

To deal comprehensively with a subject which involves an experience of nearly forty-five years would require much more of your time than should be taken on this occasion. I will, however, present as briefly as possible some of the salient points.

My first idea of braking apparatus to be applied to all of the cars of a train came to me in this way: a train upon which I was a passenger between Schenectady and Troy in 1866 was delayed a couple of hours due to a collision between two freight trains. The loss of time and the inconvenience arising from it suggested that if the engineers of those trains had had some means of applying brakes to all of the wheels of their trains, the accident in question might have been avoided and the time of my fellow-passengers and myself might have been saved.

The first idea which came into my mind, which I afterwards found had been in the minds of many others, was to connect the brake levers of each car to its draft-gear so that an application of the brakes to the locomotive, which would cause the cars to close up toward the engine, would thereby apply a braking force through the couplers and levers to the wheels of each car. Although the crudeness of this idea became apparent upon an attempt to devise an apparatus to carry the scheme into effect, nevertheless the idea of applying power brakes to a train was firmly planted in my mind.

Shortly afterwards, while I was in Chicago, the Superintendent of the Chicago, Burlington & Quincy Railroad, Mr. A. N. Towne, invited me to inspect what was then considered an ideal passenger train, namely the Aurora Accommodation. I accepted this invitation and while looking over the train, which was fitted with a chain brake, I was introduced by Mr. Towne to Mr. Ambler, the inventor of that brake. The Ambler brake, as was explained to me, consisted of a windlass on the locomotive which could be revolved by pressing a grooved wheel against the flange of the driving-wheel to wind up a chain which extended beneath the entire train over a series of rollers attached to the brake levers of each car and so arranged that the tightening of the chain caused the brake-levers to move and thereby apply the brake shoes to the wheels. I ventured to say to Mr. Ambler that I had been working upon a brake myself, but was immediately informed by him that there was no use working upon the brake problem, because he had devised the only feasible plan, which was fully protected by patents. Mr. Ambler's opinion and advice, however, proved to be an incentive to a more energetic pursuit of the subject.

As an improvement on Mr. Ambler's plan, I considered the use of a long cylinder to be placed under the locomotive, the piston of this cylinder to be so connected to the chain that it could be drawn tight by the application of steam from the locomotive boiler with a force which could be more accurately controlled than was possible with the windlass arrangement. A short study of this idea showed that it would be impossible to have a cylinder long enough to operate a chain brake upon more than four or five cars, whereas trains of ten and twelve passenger cars were frequently run upon the important railways.

My next thought was the placing of a steam cylinder under each car with a pipe connection extended from the locomotive beneath its tender and under each car, with flexible connections of some sort not then thought out, so that steam could be transmitted from the locomotive through the train pipe to all of the cylinders; but, as in the case of the attempt to improve the chain brake, it required but little time with some experimentation to disclose the fact that it would be impossible, even in warm weather, to successfully work the brakes upon a number of cars by means of steam transmitted from the locomotive boiler through pipes to brake cylinders.

Shortly after I had reached this conclusion, I was induced by a couple of young women who came into my father's works to subscribe for a monthly paper, and in a very early number, probably the first one I received, there was an account of the tunneling of Mount Cenis by machinery driven by compressed air conveyed through 3000 ft. of pipes, the then depth of that tunnel. This account of the use of compressed air instantly indicated that brake apparatus of the kind contemplated for operation by steam could be operated by means of compressed air upon any length of train, and I thereupon began actively to develop drawings of apparatus suitable for the purpose and in 1867 promptly filed a caveat in the United States Patent Office to protect the invention. In the meantime, I had removed from Schenectady to Pittsburgh, where I met Mr. Ralph Baggaley, who undertook to defray the cost of constructing the apparatus needed to make a demonstration.

At that time no compressed-air apparatus of importance had within my knowledge been put in operation. The apparatus needed for a demonstration was, however, laboriously constructed in a machine shop in Pittsburgh, being finally completed in the summer or early autumn of 1868. This apparatus consisted of an air pump, a main reservoir into which air was to be compressed for the locomo-

tive equipment, and four or five cylinders such as were to be put under the cars, with the necessary piping, all so arranged that their operation as upon a train could be observed. Railway officials of the Pennsylvania and Panhandle railroads were then invited to inspect the apparatus and witness its operation. As a result, the Superintendent of what was then known as the Panhandle Railroad, Mr. W. W. Card, offered to put the Steubenville accommodation train at my disposal to enable me to make a practical demonstration. The apparatus exhibited was removed from the shop and applied to this train, which consisted of a locomotive and four cars. Upon its first run after the apparatus was attached to the train, the engineer, Daniel Tate, on emerging from the tunnel near the Union Station in Pittsburgh, saw a horse and wagon standing upon the track. The instantaneous application of the air brakes prevented what might have been a serious accident, and the value of this invention was thus quickly proven and the air brake started upon a most useful and successful career.

Prior to the construction and practical test of the air brake, I had opportunities while traveling to present the subject to numerous railway officials and to endeavor to secure their coöperation in the development of the apparatus. None of those approached appeared to have faith in the idea, though I afterwards found that the acquaintances made and the many discussions I had had with railway people were of great advantage in the introduction of the air brake upon the railways with which they were connected.

I suppose many persons present have heard or read the story of an alleged interview between Commodore Vanderbilt and myself about the application of air brakes to the New York Central. The story as told seems to have appealed to the imagination of many people. As a matter of fact, there is no foundation whatever for that story. From the moment when the practicability of air brakes was demonstrated to the present hour, there has been nothing but satisfaction and pleasure in being associated with an invention which has contributed so much to the safety and comfort of travelers and so greatly to the prosperity of railways.

In the development and introduction of the air brake, I was controlled by the apparent fact that the apparatus would have to be uniform upon all cars to provide for the convenient change of the composition of trains. It also was most obvious, in view of the crying demand for some better means for stopping trains, that some power brake would inevitably be universally applied to all of the cars

and engines upon all railways. These ideas naturally involved a further one, namely, the importance of having all of the brake apparatus made by one company, so as to insure absolute uniformity and consequent interchangeability, and this led to the formation of the Westinghouse Air Brake Company early in 1869.

The essential parts of the air brake as first applied were:

a An air-pump driven by a steam engine receiving its supply from the boiler of the locomotive

b A main reservoir on the locomotive into which air was compressed to about 60 or 70 lb. pressure per sq. in.

c A pipe leading from the reservoir to a valve mechanism convenient to the engineer

d Brake cylinders for the tender and each car

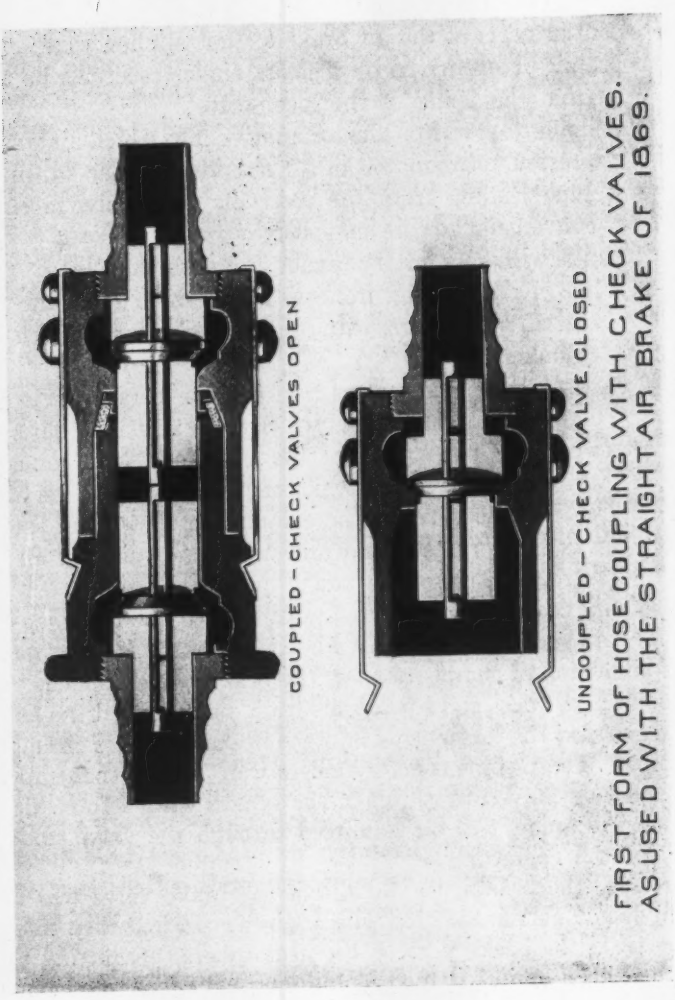
e A line of pipe leading from the brake valve under the tender and all of the cars, with a pipe connection to each brake cylinder

f Flexible hose connections between the cars provided with couplings having valves which were automatically opened when the two parts of the couplings were joined and automatically closed when the couplings were separated so that the valve of the coupling at the end of the train was always closed and prevented the escape of air when introduced into the brake pipe

The piston of each cylinder was attached to the ordinary hand-brake lever in such a manner that when the piston was thrust outward by the admission of compressed air, the brakes were applied. When the engineer had occasion to stop his train, he admitted the air from the reservoir on the locomotive into the brake cylinders through the train pipe. The pistons of all cylinders were, it was then supposed, simultaneously moved to set all of the brakes with a force depending upon the amount of air admitted through the valve under the control of the engineer.

To release the brakes, the handle of the brake valve was moved so as to cut off communication with the reservoir and then to open a passage from the brake pipe to the atmosphere, permitting the air which had been admitted to the pipes and cylinders to escape.

The success of the apparatus upon the first train was followed by an application of an equipment to a train of six cars on the Pennsylvania Railroad, and in September 1869, this train was placed at the disposal of the Association of Master Mechanics representing numerous railways, which association was then in session at Pittsburgh.



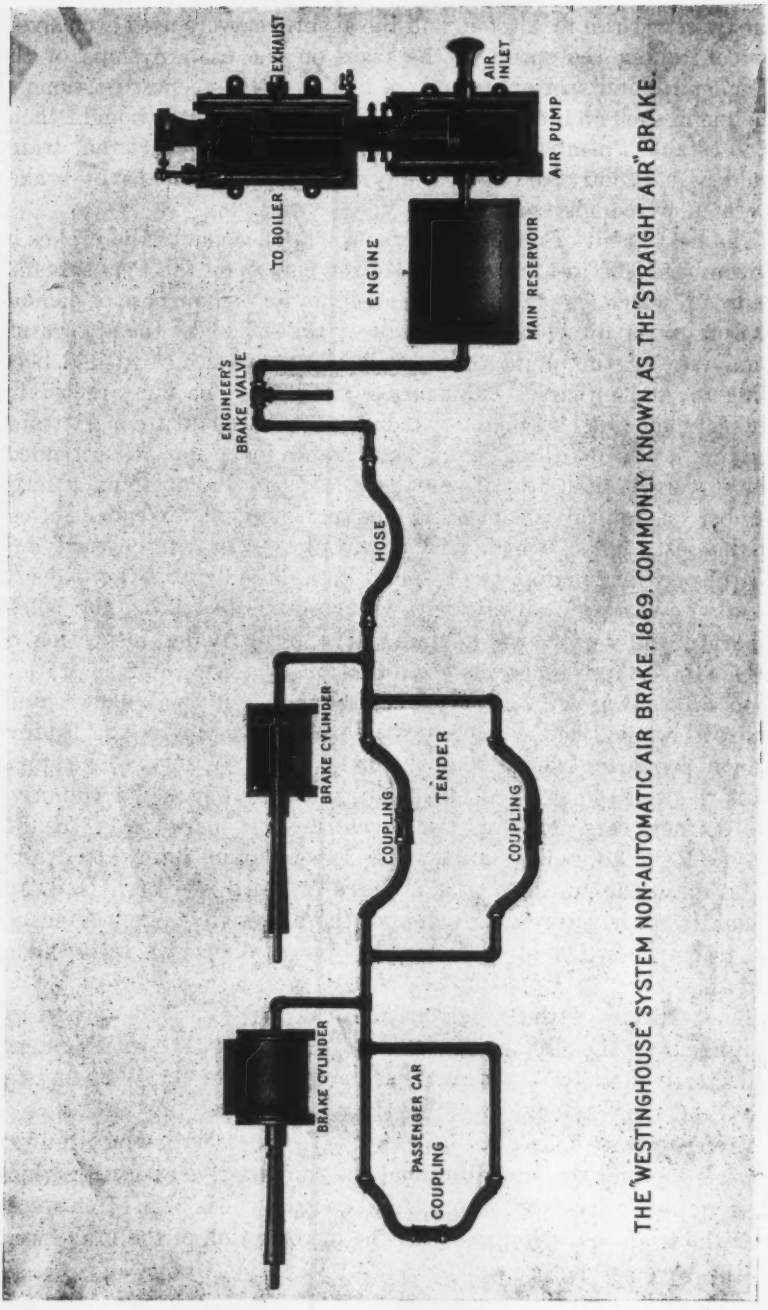
FIRST FORM OF HOSE COUPLING WITH CHECK VALVES.
AS USED WITH THE STRAIGHT AIR BRAKE OF 1869.

The train was run to Altoona and the air brakes were used exclusively for controlling the speed of the train on the eastern slope of the Alleghenies, and special stops were made at the steepest portions of the line in such an incredably short distance (as we all thought then) as to establish firmly in the minds of all present the fact that trains could be efficiently and successfully controlled by means of brakes operated by compressed air.

The next event of importance was the application of the brakes in November 1869, to a longer train of ten cars upon the Pennsylvania Railroad, which was taken to Philadelphia for the purpose of demonstrating to the directors of that railway the success of the apparatus. I may say at this point that the Pennsylvania Railroad had been using for some years a chain brake similar to the one applied by Mr. Ambler, but had found that its use was limited to short trains and that it was not a satisfactory contrivance for the purpose intended. There were invited to witness these trials in Philadelphia a large number of railway people and the papers gave extended notices of the tests made, which brought to the train on the next day Mr. George L. Dunlop, the General Superintendent of the Chicago & North Western Railway, who was desirous of having the whole apparatus fully explained to him. The result of his inspection of the air-brake apparatus was an invitation to make a demonstration upon his railway in Chicago, and he offered, if the Pennsylvania Railroad would send a train for the purpose, to invite the leading railway people and members of the press of that vicinity. The apparatus was then transferred to a train consisting of a new locomotive and six new cars, and this train was run to Chicago over the Ft. Wayne Railroad, and a number of tests were immediately afterwards made upon the tracks of the Chicago & North Western Railway, evidently to the entire satisfaction of those present. From Chicago, the train proceeded to Indianapolis, where other tests were made, and then back to Pittsburgh.

The outcome of these demonstrations was immediate orders for equipment for the Michigan Central and the Chicago & North Western, and shortly after for the Union Pacific Railway in the West and for the Old Colony and the Boston & Providence roads in the East.

I refer to these details to illustrate the readiness with which railway officials took up this invention and the comparative ease with which the required orders were secured, and because it has been often stated that the trials and tribulations in the introduction of the brake were of the severest nature.



THE "WESTINGHOUSE" SYSTEM NON-AUTOMATIC AIR BRAKE, 1869, COMMONLY KNOWN AS THE "STRAIGHT AIR" BRAKE.

Works were built in Pittsburgh for the manufacture of the apparatus and were fitted with the best tools obtainable. Standards were adopted and adhered to in the parts of the apparatus which required uniformity in construction in order to insure interchange of the rolling stock so fitted upon various roads. I think I am safe in saying that the course pursued in the manufacture and introduction of the brake had a more important bearing than anything else in deciding the Railway Master Mechanics and Master Car Builders a few years later to take up the question of the standardization of various parts of cars in order that repairs could be more conveniently made.

It soon developed that it took considerable time to apply the brakes with full force and a longer time to release them, and that in the event of a break-in-two of a train (a frequent occurrence in those days) the rear section would be uncontrolled, and when this occurred upon an ascending gradient, the rear detached section might run away with disastrous results. To overcome this difficulty a new development was necessary, the outcome of which was what has since been known as the automatic air brake.

In the automatic air brake equipment there were the same air-pump, reservoir, train pipe and brake cylinder, but in addition to these there were two important features added to the tender and each car equipment; the first, an auxiliary reservoir, and the second, a triple valve or device interposed between the brake pipe, brake cylinder and auxiliary reservoir. This triple valve was so constructed that when air was admitted to the train pipe, an opening was established between the train pipe and the auxiliary reservoir whereby the train pipe and the reservoir were filled with air under pressure. The valve also opened a passage from the brake cylinder to the atmosphere. This was the normal condition of the apparatus when the brakes were off. To apply the brakes, the engineer discharged a portion of the air from the train pipe, whereupon the triple valve closed the connection between the brake pipe and the reservoir and between the brake cylinder and the atmosphere and then opened a passage from the auxiliary reservoir to the brake cylinder, the piston of which was moved outwardly by the air from the auxiliary reservoir so as to apply the brakes. The restoration of the pressure within the brake pipe released the brakes and recharged the reservoir. This development occurred during 1872 and 1873.

The automatic brake was at that time supposed to be instantaneous in its action in applying the brakes, and almost instantaneous in releasing them. In the event of the escape of air from the train pipe

by its rupture or by the separation of the train, the air stored in the auxiliary reservoirs instantly and automatically applied the brakes to all parts of the train and they could be released only by repairing the damage and restoring the pressure, or by means of special release valves operated by the train men.

The automatic brake having proved itself vastly superior to the plain or straight air brake first described, it soon became a standard but during the transition period an automatic brake was easily converted into a plain brake by a manually operated special valve arranged in the casing of the triple valve.

The gradual increase in the length of freight trains and the numerous accidents due to lack of brake control early suggested that automatic air brakes should be made a part of the equipment of all freight trains and to determine the practicability of the automatic brake for this purpose a train of fifty cars was fitted in the early '80s and taken over the Alleghenies on the Pennsylvania Railroad, and the tests made demonstrated that such a train could be controlled on the heaviest gradients by this means.

In 1885 the Master Car Builders appointed a committee to report upon the feasibility of the application of brakes to freight trains, and this committee inaugurated what are now known as the Burlington (Ia.) brake trials made in 1886 and 1887. There were presented two trains fitted with air brakes, one fitted with a vacuum brake and one with the brake operated by means of attachments to the drawbars similar to the conception first referred to. Each of these trains had fifty cars. These tests proved the inadequacy of the type of automatic air brake then presented by the Westinghouse Air Brake Company, as well as the inadequacy of all the other brakes then tested.

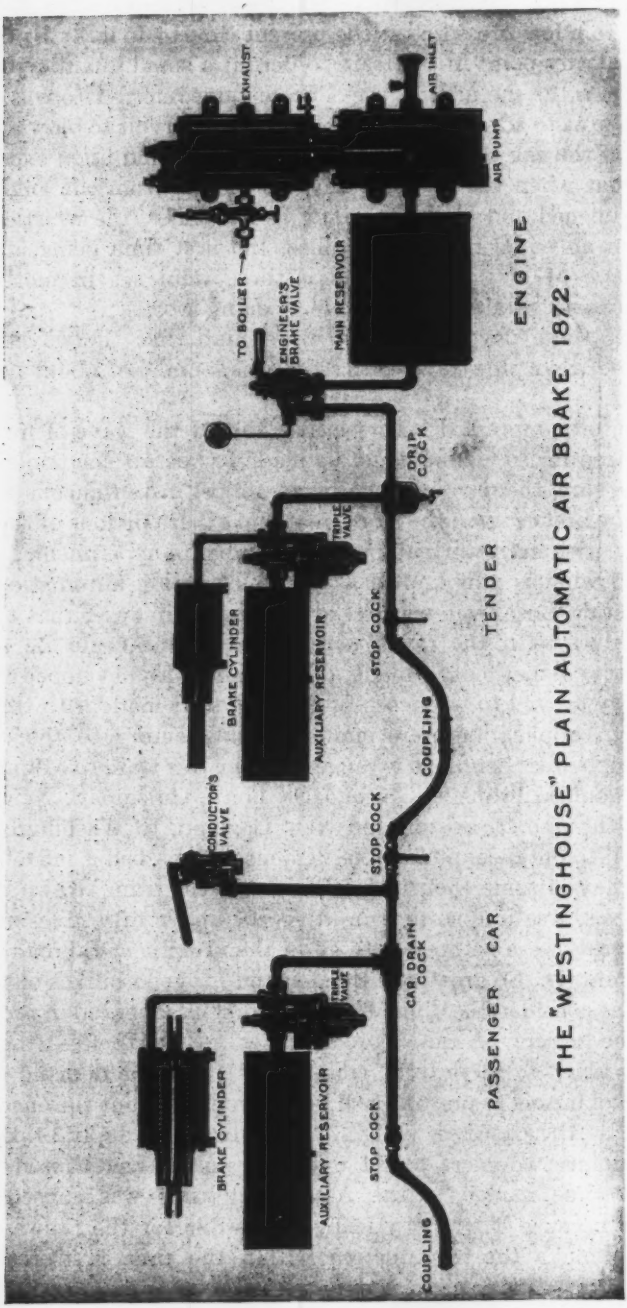
It becoming apparent that the lack of success at Burlington was due to the comparatively slow application of the brakes upon the rear portion of the train, the effect of which was to cause most serious shocks almost like collisions, a new development was imperatively needed in order to insure the successful handling of freight trains of fifty cars.

As a part of the automatic air-brake passenger equipment, I had developed in the '70s a system of train signalling involving the use of a second train pipe, which is now in general use upon all of the railways. This signalling apparatus had a sensitive valve device connected to a small reservoir upon the locomotive and these were so arranged that when compressed air was admitted through a small opening into the signalling pipe, both the pipe and reservoir were

charged to a low pressure (at the present time to 45 lb.). By opening a valve at any point in the train to permit a small quantity of air to escape from the signal pipe, the delicate valve referred to was caused to move so as to admit air from its auxiliary reservoir to blow a whistle located in the cab of the locomotive. It was found upon experimentation that when the valve in any car remote from the engine was quickly opened and closed as many as five times, the whistle would be blown an equal number of times, the first time being after the last escape of air; that is to say, there were set in motion five distinct waves of air each capable of doing work.

During these developments it was found that the waves of air within the brake pipe traveled as rapidly as sound, i.e., about 1100 feet a second.

Being fully impressed with the idea that if the wave of air which was utilized for signalling could be made to operate the triple valves upon the cars, there would then be an almost instantaneous application of the brakes upon the front, rear and other portions of the train, this idea, with hard work and a large number of experiments, shortly produced what is now known as the quick-action automatic brake. The Westinghouse train was left at Burlington in order that the new triple valves with the quick action attachment could be applied and further experiments made. The valves as developed for this emergency proved to be successful and the tests made with this train after their application were eminently satisfactory to the railway officials. It was thereupon arranged to take this train to Minneapolis and St. Paul, Milwaukee, Chicago, St. Louis, Cincinnati, New York, Albany, through to Boston and New England, to Washington, and then to Pittsburgh, innumerable demonstrations being made during this journey of some thousands of miles. This train, drawn by two locomotives, was frequently run at speeds above fifty miles an hour and the tests were witnessed by all of the prominent railroad people of the country. So great was the demand for good brakes on freight trains that considerable difficulty was at first experienced in promptly filling the orders of railway companies. Nevertheless, the wide publicity given to these tests, coupled with a public demand for the adoption of means to prevent accidents, brought about the enactment of a law by the Congress obliging the railways to apply brakes and also automatic couplers to all freight trains in the United States within a time named in the Act, which time was subsequently extended because it was physically impossible for the railway companies to make the introduction within the time first prescribed.



THE "WESTINGHOUSE" PLAIN AUTOMATIC AIR BRAKE 1872.

The quick-action automatic brake was operated like the first automatic brake for ordinary train movements; the quick action resulted only when it was necessary to apply the brakes for an emergency.

No sooner had the quick-action automatic brake been developed to operate successfully on trains of fifty cars than new conditions were presented. Steel freight cars carrying enormous loads had in the meantime been developed and freight locomotives had been increased in capacity, so that trains were often composed of 70 to 80 cars and more recently some trains have had as high as 100 cars. This possibility had, however, been foreseen and experiments were constantly being carried on so to improve the apparatus, that it could be used to control trains of any practical length; and these experiments also had in view the more nearly instantaneous action of the brakes for ordinary service purposes than was possible with the automatic brake or with the quick action brake. The result was a most important development.

The present improved triple valve has the emergency feature, but it also has what is known as the quick-service application feature; that is, for ordinary purposes the air is admitted to all of the brake cylinders so quickly that the longest freight train can be handled with almost the precision obtainable in the control of passenger trains of from six to twelve cars.

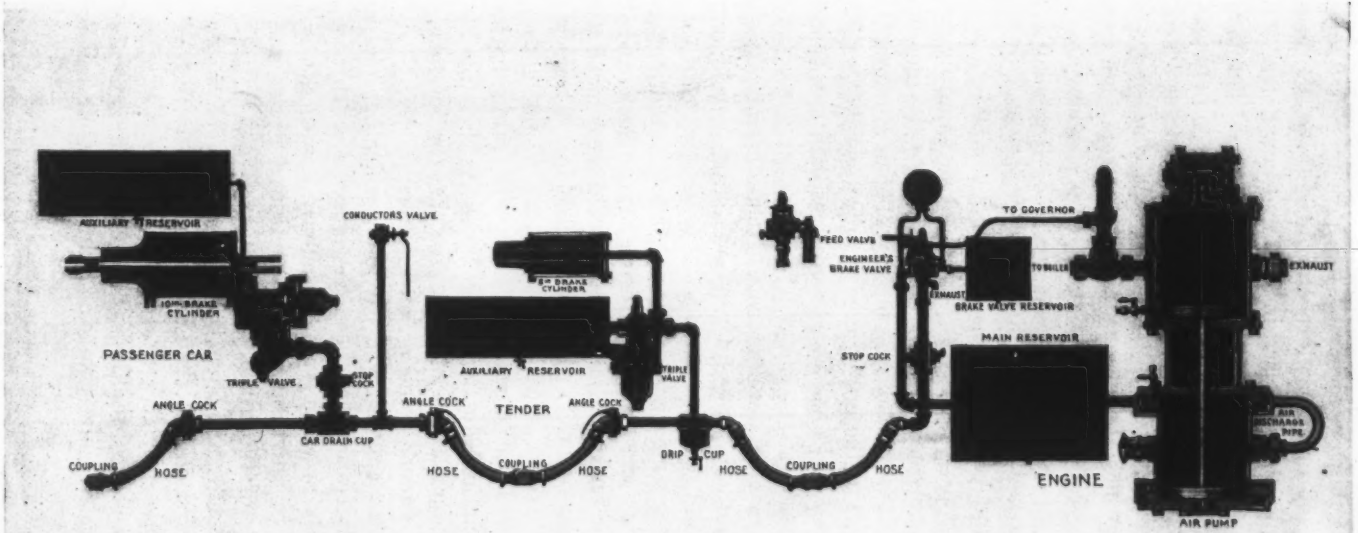
In the matter of the development of the brakes for operation upon passenger trains, nothing that skill and perseverance could suggest has been omitted in securing the highest degree of perfection. The requirements during the past few years, by reason of the greater weight of cars and locomotives and of the higher speeds at which they are run, have necessitated the redesigning of all of the passenger train brake apparatus, including the method of attaching the brake shoes to the cars and the levers and connections for bringing these shoes to bear with the required pressure upon the wheels. For the purpose of insuring the highest efficiency, every wheel of a passenger train, including those under the locomotive, is now acted upon, whereas formerly many of the master mechanics and engineers were apprehensive that it would not be possible to make use of all of the wheels of a locomotive for braking purposes.

During the past twelve months, most elaborate tests of the latest form of apparatus for passenger service have been carried out under the direction of officials of several railways and of the Westinghouse Air Brake Company, in order to prove the operativeness of the new constructions and their capability to insure the highest degree of efficiency.

From the very beginning of its operations, the Brake Company has maintained a strong staff of experienced engineers, some of whom are located in each of the large railway centers and whose services are always at the command of the railways. It is the duty of one or more of these trained men to proceed to the scene of any accident that may have occurred in order to ascertain the cause, to report thereon and to render such aid and coöperation to the railway officials as will tend to avoid a like accident if in any manner the brake can contribute to that end.

The Air Brake Company has always had in its works, for experimental purposes, sets of brake cylinders, pipes and couplings, representing the apparatus upon trains of various lengths, so that tests and demonstrations could be readily made for all sorts of purposes, including the educating or informing of railway officials who came to seek information. To spread this information more effectively, the company about fifteen years ago constructed and equipped a special instruction car in which were arranged 50 sets of brake cylinders and pipes equivalent to like apparatus upon a freight train. This car was provided with a boiler to drive the air-pump for the production of the air under pressure needed to operate the brakes. Operative models of all parts of the apparatus were shown in section so that their construction and operation could be more quickly comprehended. This car, in charge of experienced instructors, was moved from place to place, and engineers, firemen, conductors, and other train employees in general visited it to familiarize themselves not only with the operation of the brake but with its construction, and in this manner there has been developed throughout the country a knowledge of the air-brake art which has proved of inestimable value to the railway corporations and their patrons. The records of the Westinghouse Air Brake Company show that to December 1, 1910, their instruction car had travelled over 113,000 miles. Numerous railways have also provided their own instruction cars, so that it may be safely said that every railway employee having anything to do with the operation of trains, freight or passenger, has been required to familiarize himself with the working of the brakes and so to study the subject that he could pass an examination, 280,258 employees having so far been examined by representatives of the Westinghouse Air Brake Company, and in numerous cases these men have been required to show sufficient knowledge of the brake to entitle them to receive certificates of their proficiency.

The importance of the maintenance of the brake to railways has



THE "WESTINGHOUSE" SYSTEM QUICK ACTION AUTOMATIC BRAKE 1887.

not been overlooked by railway officials. They have appointed superintendents of brakes and numerous inspectors, and there is an association of air-brake officials, organized in 1893 and now having 1015 members, who meet annually in convention to discuss thoroughly the questions which are constantly arising, so that today there exists an organization of which scarcely any of the public has ever heard—an organization which is constantly devoting skill and energy to the care of apparatus which above everything else in connection with railways contributes to the safe transportation of passengers and freight.

I have often been asked how many lives have been saved by the use of the air brake and I have as often said it might well be a great many thousand, but that it was impossible to make even an approximate estimate. At a banquet given in Washington to the members of the International Railway Congress in May 1905, a diplomat, in speaking on the subject of the importance of railway brakes, said he felt safe in saying the air brake had saved more lives than any general had ever lost in a great battle.

I have spoken of four chief developments. It has been necessary, in order to avoid disastrous consequences, that each development should be of such a kind that cars fitted with newer apparatus could operate with little inconvenience with cars fitted with earlier apparatus. As it stands today scarcely any of the old type of brake and the first type of automatic brake are in use, but should a car fitted with the first form of automatic brake be found and put into a train with the more modern apparatus, such older apparatus would be found to operate fairly well with the more perfect form. The prevailing idea in the development and introduction of the brake has therefore been an adherence to such uniformity of apparatus that the interchange of traffic over various roads could go on uninterruptedly.

There is probably no apparatus in use today which has received such thoughtful consideration and been the object of such care in every one of its details as what is now popularly known as the air brake, and which is in universal use in the United States and in many other countries of the world.

In my estimation, there could be no better illustration of the value of the maintenance of standards than has been given by the manufacture and introduction of air brakes upon railways, for without such standards, train brakes would not have come into general use, with consequences which railway officials and the public can well appreciate.

My story would be incomplete without a reference to the splendid assistance which the railways of this and many other countries have rendered. They have been lavish in providing those facilities for making the thousands of tests which were necessary to progress in the developments I have recited; to the Pennsylvania Railroad especially, upon which the most important experiments were first made, the other railways of the country, as well as the traveling public, owe a debt of gratitude. When a railway (as did the Southern Pacific two years ago) provides a new train of one hundred steel cars to be fitted with the newer form of automatic brake, in order to carry on, with a staff of skilled men under the direction of the chief officers of the company, a series of experiments upon its heaviest gradients, requiring several weeks, for the purpose of securing greater safety and an increased carrying capacity per train, with the consequent lessening of the cost of transportation, it is just that the managers of such a corporation should receive credit for their farsighted policy. To name the railways and merely to state chronologically the tests of brakes which have been made during forty years would require several volumes.

It only remains for me to say that I am extremely gratified by the patience and attention with which you have listened to the reading of this address, and I am amply repaid if what I have said has been illustrative and interesting to you.

THE MECHANICAL HANDLING OF FREIGHT

By Samuel B. Fowler

ABSTRACT OF PAPER

Lack of adequate terminal facilities, increase of net income and lower freight rates present problems the solutions of which are vital to the transportation company, shipper and consignee alike. Additional facilities are difficult to obtain, since there is usually no available land adjacent to the terminal or it is held at a prohibitive price. The capacity of present terminals can be increased by handling larger unit loads and moving them at greater speed, as well as by increasing the floor area by the use of freight sheds of more than one story. This is made possible by the substitution of mechanical devices for manual labor and hand trucks.

The terminal handling cost is a large item in freight charges. Mechanical handling methods will reduce the total transportation cost sufficiently to permit of a material gain in income, a decrease in rates, or possibly both.

The use of machinery will also bring about a new type of terminals and a revolution in present terminal methods, making possible other important economies. These economies are possible with team freight as well as l.c.l. freight, and with water-borne traffic as well as rail-borne traffic.

The problems thus presented should be worked out with a mind free from the bias caused by long familiarity with present practices.

THE MECHANICAL HANDLING OF FREIGHT

By S. B. Fowler, Boston, Mass.

Non-Member

The usual discussion of this subject has dealt almost entirely with the merits of mechanical versus manual handling of freight as viewed from the point of saving in costs, principally in relation to the present type of terminal and freight shed.

2 Further consideration of the problem shows that it has a far reaching effect on the whole transportation question and a full discussion of the subject cannot fail to bring out its direct or indirect bearing on every phase of the freight transportation problem. Its application has a direct and important bearing on the costs of transportation and even a more direct effect on the efficiency of the transportation system as a whole.

EFFECT OF TERMINALS ON TRANSPORTATION

3 I wish at the beginning to emphasize this feature of the subject and to make it plain that the object aimed at is not wholly the reduction in the cost of handling goods at freight stations, although that is a result well worth accomplishing, but to show as well the possibilities in increasing the general efficiency of transportation.

4 It must be admitted that there is a widespread demand, on the part of the public at least, for a decrease in freight charges and improvement in the efficiency of the service, the need for which is also recognized by the transportation companies themselves.

5 In a paper by James J. Hill, chairman of the board of directors of the Great Northern Railroad, presented last June before the National Association of Millers, the inefficiency of the country's transportation service is strongly emphasized and is emphatically stated to be due to inadequate terminal facilities. He also states

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

that the pressure upon existing terminals is a present menace and a future handicap; that the problem of terminals is the greatest problem of the country and that if neglected for the next five years as it has been during the last ten the results will be disastrous.

6 That a reduction in the cost of terminal freight handling will make possible a material reduction in rates, a material increase in the net income to the transportation companies or perhaps a combination of both can be easily shown. It is almost wholly a terminal problem. This is, in fact, so far considered to be true that the following have become recognized axioms: (*a*) the efficiency of a transportation system is limited, not by its carrying capacity, but by its terminal facilities; (*b*) the essential factor in transportation costs is not the cost of hauling the goods, but the expense of handling at terminal stations.

7 It is obvious that there can be no improvement either in the efficiency of the service or in its carrying capacity by the mere addition of more trains when the present inefficiency is due to congestion in yards and terminals. I do not understand that it is contended by anyone that the actual capacity to haul goods has been anywhere near reached. In the last few years immense sums of money have been expended in straightening out curves, cutting down grades and in other ways adapting the permanent way for the use of larger cars and more powerful locomotives, until a point has been reached where any further reduction in the cost of transporting freight is of no material importance. In water transportation there has been the same increase in carrying capacities and motive powers and any further reduction in transportation costs must be brought about by a decrease in the terminal expenses.

8 That this fact may be appreciated let us take as an example the item of miscellaneous package freight, known in railroad practice as L.C.L. freight; and as I shall occasionally use certain statistics let me say a word now regarding them.

9 It is well recognized that statistics of transportation costs are to a certain degree unsatisfactory and more or less unreliable when it comes to comparisons. This is due largely to the lack of uniformity in methods employed in arriving at results as well as to a variance in practice as to what items are included in calculating a given cost. In the selection of any figures used, only conservative ones have been taken and those given by reliable authorities.

10 The actual cost of transporting freight by rail can safely be stated as 3 milis per ton-mile, which includes the operating expense

and interest on rolling stock and permanent way investment. This figure is for the average freight traffic; bulk freight, such as ore or coal, can be hauled for less.

11 A careful study of the published costs of handling L.C.L. freight at terminals seems to warrant, as a conservative estimated cost, 40 cents per ton for outbound and 35 cents per ton for inbound freight, a total terminal charge of 75 cents on each ton. That the cost of transportation may equal the terminal cost, this ton of freight must be hauled 250 miles; but the average ton-haul is only 135 miles.

12 The cost of hauling this distance is 40 cents; added to the terminal expenses of 75 cents, the total cost of transporting one ton the average haul is $1.15, 65 per cent of which is therefore terminal expense. It is estimated that in terminals provided with machinery for freight handling the terminal cost can be reduced at least to about one-quarter of its present expense, or to 19 cents per ton.

13 The total transportation cost would then amount to 59 cents per ton, a decrease in total cost of practically 50 per cent.

14 I believe, it is perfectly plain that the problem before us is one of terminals only. It is an engineering problem along the broadest lines.

15 It is not a problem of designing a machine or a system of machines adapted to the transference of goods between freight sheds and cars or vessels, but rather the adaptation of well-known devices to this work; not the simple adaptation of machinery to the transportation of merchandise, but a study of the effects of such adaptation on methods to be employed at terminals in the future; not the introduction of machinery in the present type of terminal, but rather the designing of an entirely new style of terminal adapted to the use of machinery.

16 Not long ago the cost of loading ore at the ports on the Great Lakes was 35 cents per ton; it now costs less than 2 cents per ton. This has been accomplished by the use of machinery in loading and by the design of a different type of terminal, adapted to the use of this specially designed machinery.

17 In considering the transportation terminal problem we have to deal with two distinct types of terminals, one for rail-borne freight, one for water-borne freight. The inefficiency of each method of transportation is the same, that of inadequate terminal facilities. We will discuss each problem separately, bearing in mind, however, that much of the general discussion of one type relates directly to the other.

SOLUTION OF THE TERMINAL PROBLEM

18 The solution of the terminal problem resolves itself into two factors, the increase in capacity and the reduction of terminal costs.

19 On first thought the natural solution of the first factor is the purchase of more land, thus increasing by as much as is necessary the area required to handle the increasing traffic.

20 Unfortunately the land adjacent to the average terminal has so increased in value that its cost, for terminal uses, is prohibitive; the interest on the required investment would be a greater fixed charge than the traffic would warrant. In addition the necessary increase in area would involve an increase in operating expenses, particularly in the trucking costs, which is the largest item in the handling expense.

21 That the present terminals are worked to their capacity is evident; no additional truckers can be put to work as they are already in each others way, every truck is carrying its capacity in bulk or weight and is moved at its maximum speed, and still the freight is coming in faster than it can be handled. Congestion is the result and congestion means rehandling, which spells additional expense.

22 With these limitations imposed it is evident that to increase the capacity of the terminal we must increase the unit movement; that is, in moving goods to and from the cars, more freight must be taken in each load and this increased load must be moved at greater speed. Manual labor must be eliminated as much as possible, for in no other way can larger loads be handled and at greater speeds.

23 The most feasible method of bringing about these necessary improvements seems to be the substitution of machinery for hand trucks and manual labor, wherever possible. This substitution would in general have the following marked effects on the capacity of a terminal:

a If this machinery were of the overhead type, that portion of the shed floor now necessarily kept free for truck runways would at once be available for the receiving, weighing and sorting of merchandise.

b As the mechanical transporter could carry much greater loads and at much faster speeds, goods would be removed from the receiving floor more rapidly and the capacity for receiving new loads correspondingly increased. For the same reason cars would be unloaded much faster and, as it is practically as cheap to tier goods as to set

them on the floor, the capacity of the inbound shed would be increased accordingly. The cost of tiering by hand is now prohibitive, it being equivalent to a rehandling.

c In mechanical transportation the increase of a few feet in the distance traveled has an immaterial effect on the time or the cost of transportation. The delivering and receiving platform capacity could be practically doubled if both sides of the sheds could be used to receive from or deliver to teams.

d As the time consumed and the cost of hoisting or lowering a few additional feet is unimportant, upper floors could be utilized and a large increase in floor area thus obtained.

e Freight-handling machinery could be utilized to assist in the loading and unloading of teams and the time consumed in this operation could be materially reduced.

24 There are equally striking possibilities in reducing the cost of handling freight. The entire cost of handling L.C.L. freight is practically in the labor involved and the wages of truckers is the largest item.

25 A single transporting machine operated by one man should be able to replace at least 16 truckers. The "spotting" of cars, an expensive tedious operation, could be entirely done away with.

26 With a properly designed terminal the shifting of cars from the inbound unloading tracks to the outbound loading tracks could be largely eliminated; it might be possible to approximate closely that ideal condition where the movement of an empty car about the yards becomes unnecessary. Even the partial elimination of these operations would reduce the number of switching engines and crews, and the saving represented by the cost of operation of only one engine and crew is the interest on a considerable investment.

27 Much of the damage to freight for which the transportation companies must eventually pay comes from yard switching and the recoupling of "spotted" cars. Added to this expense is the damage done to the rolling stock itself.

28 Numerous economies could also be brought about in the operations of sorting, weighing and distributing. The full economies that could be effected and the entire possibilities as to increased capacities could not be fully realized without a careful study and discussion of the minute details of the problem; but in a paper of this character we must confine ourselves only to the general details, pointing out the methods applicable and the type of machinery best suited for this service.

COMMENTS ON MODERN INSTALLATIONS

29 The application of machinery to freight handling in railway terminals is of very recent date as is also the interest in such applications. At the Sixth Session of the International Railway Congress held at Paris in September 1900, a committee previously appointed made its report covering practically all the railway systems of the world. The gist of this report was that the use of machinery at freight stations was extremely limited, although in one or two instances the installation of such equipment had been proposed. The only use was that of elevators where stations were of more than one floor, and a limited application of cranes, some hand-operated, some hydraulically and a few electrically.

30 It will be noted that the applications are limited to vertical movement alone, except as to the radius of the crane jib. No recognition is apparent of the need of horizontal movement for the purpose of distribution.

31 Since that time, however, England in particular, has made more or less progress and I believe a brief description of one of the more modern and complete installations will be of interest.

32 This equipment is installed in the North-Eastern Railway Company's warehouse, New Bridge Street, Newcastle. The station contains two floors and a basement; the basement and the first floor being utilized for the regular in- and out-traffic, and the top floor for storage and warehouse purposes. The first floor is provided on the inside with two platforms approximately 300 ft. long and 25 ft. wide, between which is a double line of car tracks. Each platform is served by two overhead traveling cranes of the conventional type of overhead shop cranes, and each can travel the length of the building parallel with the freight car track, except as limited by the position of another crane. Mounted on this traveling crane is a traveling, revolving jib crane having a lifting capacity of one ton. Each of these units is, therefore, provided with four motors, the traveling cross-traversing, revolving and hoisting motor, with a speed at capacity load respectively as follows: 350 ft., 150 ft., 250 ft., and 150 ft. per min. On the outside wall are two revolving jib cranes each equipped with two motors, one for hoisting, the other for revolving, the respective speeds being 60 ft. and 150 ft. per min.

33 The basement has the same arrangement of platforms and tracks, each platform having one crane identical with those of the first floor. There are in addition one car traverser for moving cars

the length of the basement and two car elevators having a lifting capacity of 20 tons and a lowering capacity of 30 tons. Revolving pillar cranes are also installed. A transporter capable of hoisting to the floor level and transporting the length of the building is provided on each side of the building for operation on the top floor.

34 Inside the top floor are six electric hoists operating through hatches from the floor below. There are also the usual number of capstans without which an equipment would be considered incomplete. The maximum lifting capacity of all apparatus except the car elevators is one ton, and the speed of operation of each varies considerably.

35 In an earlier installation where stationary revolving cranes of the hydraulic type were used the horse power per 1000 sq. ft. of platform was 30.3 and the lifting capacity 1.4 tons for the same area. In the later installation just described but 6.13 h.p. for each 1000 sq. ft. of area was needed and a lifting capacity of but 0.27 tons.

36 It will be noted that this installation is defective in two very important respects:

a The horizontal or distributing movement is limited to straight lines and does not cover areas. Those units which have a horizontal movement are limited in action to the platform which they serve and also as to the amount of this platform over which they can travel by the position of the other pieces of apparatus. It is impossible for them to reach any portion of their own platform beyond the other unit.

b All the freight to be handled must be brought to the freight house and all cars to be loaded or unloaded either to the platform inside or outside the freight house, and the range of operation of the freight-handling apparatus confined to the freight station itself.

Such an arrangement of machinery and station buildings has plainly very little effect in increasing the capacity of the terminal, but is principally advantageous in decreasing the costs of loading and unloading at the station platforms. It lacks the flexibility requisite to eliminate the hand truck and is evidently not in the least adapted to handle so-called transfer freight.

37 We are unable to suggest any installation so comprehensive in this country; in fact, we can point to no installation whatever. The United States is, I believe, universally recognized as the leader in the application of labor-saving machinery, but in this particular instance there is an entire absence of it, if we except a few isolated instal-

lations designed for some particular class of merchandise or type of package. This condition applies to all classes of freight, except such bulk freights as coal, grain or ore. The development of special machinery for handling bulk merchandise has been carried to a high degree of perfection although there is a reversion to hand methods at receiving stations where this freight arrives in small units of about a car load.

38 There are a few illustrations of freight-conveying apparatus principally confined to some type of endless belt device, or movable platform; one designed to handle barrels where large shipments of flour form an important part of the traffic; another adapted to convey baggage from the deck of a ship to the pier; still another, a movable platform incorporated in a portable gangway, designed to carry to the pier floor a loaded hand truck, with its stevedore, where the angle of the incline is too steep to permit of his pushing up the truck. An interesting installation is that at the pier of the Old Dominion Steamship Co. at Richmond, Va., where a telpherage system is in operation.

39 All of these equipments are limited not only in capacity, but in scope and serve only straight lines, not areas. In general, the merchandise passing through a railway freight terminal is of three classes: inbound, outbound and transfer freight, the inbound and outbound being further divided into L.C.L. and team freight; the L.C.L. freight passing through the freight sheds, the team freight, as its name implies, being handled in the yards from cars to teams or the reverse.

HANDLING INBOUND AND OUTBOUND FREIGHT

40 The operations in handling outbound freight are about as follows: (*a*) receiving goods from teams; (*b*) checking and receipting for same; (*c*) weighing and classifying; (*d*) sorting for the proper car; (*e*) trucking to the car; and (*f*) stowing in the car. The operation of handling inbound freight, except in the reversal of sequence, is essentially the same with the omission of the weighing, which is not ordinarily done, the weight of the shipping station being accepted.

41 In connection with these enumerated operations certain clerical and record work will be required and hand labor will continue to be a factor to some extent. But the introduction of freight-handling machinery will undoubtedly have an influence on these necessary manual operations, both as to cost and speed of handling.

Space does not permit a discussion of the details involved, but fortunately they do not have a determining influence on our problem.

42 I have already indicated that one way, at least, of increasing the capacity of a railroad terminal is to move freight to and from the cars in greater unit loads and at greater speeds; and that at the same time changes will become possible in the terminal arrangement which will permit a still greater increase in capacity as well as further important economies.

43 A mechanical system for this work must be extremely flexible; it must have both vertical and horizontal movement in the required degree; receive and deliver its loads at any portion of any floor of the freight stations and at any place in the yards to be served; occupy little, if any, space of value for other purposes; and should be simple in operation, not requiring skilled or high-priced labor for its control. The design of the equipment must be such that there must be no interference between machines, and it should be possible to add to the equipment from time to time as required without interfering with the working plant.

44 Consideration of the above requirements points to the suspended or overhead system operated by electric motors. The use of such transporting systems is now very common in industrial plants and a large number of manufacturing companies offer a variety of such appliances. These installations have been highly successful and the mechanical and electrical features of the transporting machines are satisfactorily worked out.

45 The requirements for service in a railway terminal are radically different, however, in many respects. The transporting units in operation will necessarily be far greater in number. Each unit must easily be able to reach and operate over every foot of trackage required to serve all parts of the terminal used for loading and unloading and must be able to do this without interference and without possibility of congestion. The very first effort to apply mechanical transportation of goods between cars and freight sheds or vice versa will prove that the present type of terminal is not suited for the purpose if the maximum results that can be attained are desired.

46 A conventional outbound station having a capacity of 100 cars is operated much as follows: The length of the shed will be such that a string of 20 cars can be accommodated at its side on one of the loading tracks of which there are five. One hundred cars will be placed on these tracks, five rows of 20 each, these cars having been "spotted" so that the doors of the cars abreast of each other will be

opposite one another in order to provide a continuous runway for trucks through the five cars. The opposite side of the house provides the teaming platforms for the reception of loads. The merchandise as received is placed on hand trucks, wheeled to the proper runway and through to the designated car where it is unloaded and stowed away. While the application of transporting machinery is in this case perfectly feasible and larger loads can be carried with greater speed to the designated runway, it is still necessary to push these loads through the cars to the one for which the merchandise is intended. It would evidently be a distinct gain if the transporter could set its load down directly at the proper car door. To accomplish this the loading tracks must be relocated and at least arranged in pairs with island platforms between the pairs. It would be of advantage to move the first loading track far enough from the station platform to allow for teaming space, thus doubling the receiving platform facilities at the shed.

47 The same arrangement is equally applicable to the inbound freight traffic and we thus find ourselves confronted with a rearrangement in which no car is placed at the station platforms for direct loading and unloading. It at once suggests the doing away with the distinction between loading and unloading tracks; the tracks served from the outbound and inbound stations being filled with loaded cars in the morning which will be unloaded into the inbound house and loaded from the outbound house in the same day without the need of switching the empty cars from one house to the other; at the same time the "spotting" and the recoupling being eliminated. The possibility of accomplishing this hinges on the trackage arrangement that can be worked out. The types of transporting machines now in use employ two different kinds of tracks; one type of machine is supported and propelled by single flange wheels so arranged in pairs that the wheels of each pair track on the opposite sides of the web of an I-beam, straddling the beam, as it were, the other type is supported and propelled by wheels having a double flange and running on the top of an ordinary T-rail properly suspended. Each has its advantages as compared with the other, although the true test for selection in any particular case is the cost of installation and future operation.

48 A number of lines of tracks with means of passing from one to the other will be required so that any individual transporter can reach every part of the area indicated. The I-beam type of track will therefore require an installation of permanent trackage erected

over the entire space to be served and must include at the junction points of these various tracks some type of switch included in the track itself. These switches must be controlled by the operator of the transporting machine and should be provided with suitable indicating signals showing the position of the switch as the machine approaches.

49 The T-rail type of track with transporting machine hung from wheels running on top of the rail does not require the use of tongue switches included in the tracks. Each transporter carries with it the switching apparatus which consists, in the main, of an extra set of traveling and propelling wheels that are adapted to engage, when desired, a system of trackage at a different level than that of the main track. These different levels of tracks, which we will designate as loading and unloading tracks, can be moved to any desired location within certain limits as they can be entered from any point of the main track opposite which they happen to be located. The existing conditions at the particular terminal under consideration would of course determine which system of trackage would be the best suited to the individual cases.

ARRANGEMENT OF TRACKS AND TERMINALS

50 The following diagrams are submitted to illustrate only the general idea involved. They show in a general way the application to an inbound freight station provided with six unloading or island platforms, arranged to serve ten lines of cars. Fig. 1 shows the arrangement of overhead tracks where the I-beam type of track is used. One track only being indicated through the freight house. The main track is indicated by the solid line and extends through the shed along one end of the platforms, over the platform farthest from the shed, along the other end of the platforms into the shed, where it connects with the track through it and forms a closed loop. The main track includes all of the switches necessary to divert machines either to or from the tracks serving the other five platforms. This main or loop track is normally continuous, the switches permitting a machine to enter or leave the tracks over the loading platforms being controlled by the operator of the machine. The tracks over the platforms, those requiring the operation of switches to enter or leave are indicated by dotted lines.

51 In unloading the cars the merchandise is broken out and placed on trucks, flatboards or any design of carrier that is best adapted to

the purpose and placed on the platforms ready for moving to the house by any of the machines; the operators of these can see on what platforms loads are waiting as they move along the main track at the entering end of the platforms, and by operation of the switches pass them on to the platform track where loads are ready. They are then

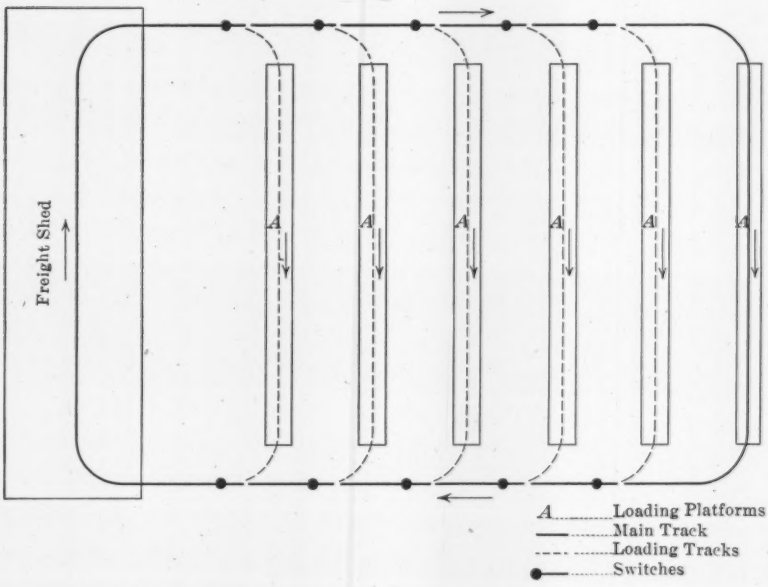


FIG. 1 ARRANGEMENT OF OVERHEAD TRACKS WITH I-BEAM RAILS

conveyed to the sheds, deposited at the proper place and the transporter is ready to return to the platforms for another load.

52 If the T-rail type of track is used no switches are required on the main or loop track; the platforms or unloading tracks are at a different level from the main track and are entered by placing the second set of wheels of the transporter in a position to engage the platform track and continue around it, at the same time lifting the main track wheel from engagement with the rail on which they are running. It is, therefore, obvious that unless it is required to unload cars at each platform at the same time, a plainly unnecessary requirement, permanent tracks over each platform are not necessary. It becomes possible in this system to suspend these platform tracks on a traveling crane parallel with the platform, operated either by hand or electric power, and to move it over the platform when it is desired to

unload cars. Under some conditions of operation one such movable platform track would be all that would be required; under other conditions two would be ample to serve the six platforms; or it might be necessary to have tracks becoming permanent at each platform. The same method of switching the transporters to the platform tracks would still be used, thus eliminating track switches.

53 At an outbound station of the same car capacity the same arrangement as already illustrated would be in general adopted, differing, however, in this respect: in loading cars it is necessary to have free access to any of the cars set all of the time, and, therefore, loading tracks must be placed over all platforms. In other words, the essential distinction between the two equipments, is that the required distribution facilities are at a different terminal of the transporting line; in both instances it is at the receiving end of the line, but in the case of outbound freight it is the car end, and in the case of inbound freight it is the freight shed end.

54 In loading goods the distribution is arbitrarily determined by the setting and the designation of the cars to be loaded. The overhead trackage in the freight shed, therefore, can be much as shown in Fig. 1, as the transporter has only to pass through the shed picking up whatever loads, properly assembled, are ready for movement to the designated car. The reverse operation would require a somewhat different arrangement of trackage in the inbound freight shed as the loads coming in require sorting and distribution to prepare them for delivery. Two main line tracks with cross tracks between them, as shown in Fig. 2, would be needed, the number and location being determined by the local requirements and the methods worked out for handling the freight on the house floor.

55 The average distance traversed by the transporter, under the conditions shown in Fig. 1, is the maximum. The addition of another main track parallel to and between those indicated in Fig. 1, will reduce the average haul materially. Addition of loop tracks at certain points will accomplish the same result. The various possible combinations of tracks are too great to attempt even to outline. They vary as much as the present arrangements of terminals themselves. It must be borne in mind, however, that in mechanical transportation up to a certain point, increase in distance traveled has an immaterial effect on the cost or time consumed and that the added expense required to reduce to the minimum the average haul would often be unwarranted.

56 Although we have referred to the inbound and outbound sta-

tions and the overhead trackage associated with them as separate units it is evident that while the freight sheds themselves can be and, under many conditions, should be separate, the trackage over the loading and unloading platforms can be used in common from either shed, and the loading and unloading platform be one and the same. Freight can first be moved from the cars to the inbound shed and then from

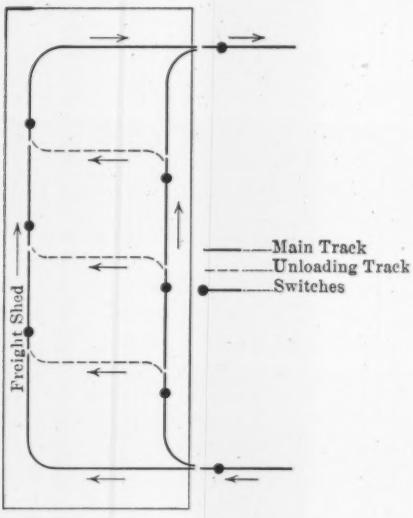


FIG. 2 ARRANGEMENT OF OVERHEAD TRACKS IN FREIGHT SHED

the outbound house to the cars for loading; or the two operations can be carried on at the same time. This arrangement makes possible a material reduction in the original investment in overhead trackage and further in the actual number of transporting machines required, as these machines can be utilized for the service of either shed.

57 Freight comes to the outbound house but slowly in the early part of the day; the rush of delivery occurring in the latter portion of the afternoon. This leaves the larger part of the equipment available in the morning for inbound freight and with a sufficient number of transporting machines the entire work of unloading can be accomplished long before the rush period of loading begins.

58 Without taking up in detail the handling of transfer freight at the regular transfer stations, the moving of goods from one car to another, it is plain that the adoption of such a system will effect the same economies in this class of service and in addition reduce the time of car detention at the transfer points.

TYPE AND OPERATION OF CARRIERS

59 In considering the transporting equipment it is evident that the control of each machine must lie in the hands of one man who travels with the machine. Automatic systems are not applicable to this work The operator, in a cab or on a platform, suspended from the traveling motor, controls the starting and stopping of the train, operates the switching devices and depending on the detail adopted may or may not control the hoisting and lowering operations.

60 Because of problems involved in sorting and loading packages for transference, too large a load cannot be put on any one carrier and, therefore, a transporting machine should convey more than one load. For convenience we will consider that on each trip four loads will be carried, although it is entirely possible to draw a larger number. We will assume the transporting device consists of five units, the traversing machine from which is suspended the cab for the operator and four trailers, each equipped with an electric hoist. There are two methods of operation in such a device; the trailers may be considered a permanent part of the device and the control of the hoisting apparatus centered in the cab, or the trailers may be detachable at the will of the operator, magnetic couplers being provided, and the control of each hoist local to the trailer itself.

61 In the case of permanent trailers, the operator not only moves the loads to their proper destination but lowers and raises them as well; where detachable trailers are used the function of the operator is simply to move empty or loaded trailers. This requires a main or traveling track always clear for continuous movement, and shunt tracks for the trailers must be provided where the operator can leave them or from which he can pick them up. The raising or lowering of the loads is then controlled by the men who handle the freight at the car or on the shed floor. The balance of the equipment required consists of the carriers attached to the trailer hoists.

62 The kind of merchandise handled at any given terminal would determine the type of carrier best adapted. It may be a simple flatboard or a wheel truck and each can be provided with detachable or hinged sides if necessary. In the case of special packages, as bales of wool or cotton for an illustration, neither flatboard nor truck would be required. Any type of carrier required at a certain terminal, can be readily designed and all so made that they are interchangeable and attachable to the hooks of the hoists.

63 In thus transporting merchandise the solution evidently does

not lie in excessive loads or abnormal speeds, but rather in a moderate limit as to both. As both the feet and the load must be hoisted and the distances traveled are comparatively small, the time required to reach maximum speed must be short. Small loads on each hoist and a total load on the transporting motor small enough to admit of rapid acceleration and quick stopping are necessary. Let us assume that the average load on each hoist will be 500 lb. and the average load on each machine one ton; the capacity of each motor being double that of this normal load to allow for variation in load. The average load of a hand truck will be less than 250 lb. and the speed of movement will average about 125 ft. per min. With an average load of 500 lb. per carrier the total load carried will be 2000 lb.; at least eight times as much as the hand truck will move each trip. The hoisting speed can be practically anywhere from 60 to 120 ft. per min. and the conveying speed anywhere up to 1000 ft. per min. That we may not overestimate in our calculation, allowing for curves, delays at switches, etc., we will limit the estimated speed to 250 ft. per min., a speed of less than 3 mi. per hr. This is, as will be admitted by everyone, an extremely conservative estimate, yet it makes it possible for one man with the transporter to accomplish the work of 16 men in the same period of time. It will be seen that the preceding is a ridiculously conservative estimate; that loads can be increased and speed of conveying easily doubled. Considering only these conservative figures it is apparent that the costs of conveying can be reduced in a tremendous degree if one man can replace 16, and the freight-handling capacity of a given floor space can be doubled if the goods can be moved twice as fast from it or to it.

OPERATIONS INVOLVED IN HANDLING MERCHANDISE

64 The various operations involved in the receiving of merchandise either at the inbound or the outbound house and preparing it for delivery to the consignee or to the car we can consider only in the most superificial way. Freight delivered to the outbound house arrives in packages of varying weights and sizes, and anything from a full load of one kind of goods consigned to a single destination to a load in which there are as many classifications and destinations as there are packages.

65 In many cases it is possible to have the packages piled on flatboards, to be instantly removed from the teams by the transporting machines. This would mean a great reduction in the time a team

would have to stand at the platform, a direct saving in trucking expense to the shipper, a relief to the team congestion at platforms and an increase of the platform receiving capacity.

66 Where deliveries for one destination are sufficient in amount to constitute an average trailer load all manual handling can be entirely eliminated as the transporting machine can remove the goods direct from the team, run the load over a scale included in the overhead track and then move it to the proper car for loading. Where a delivery is a load of various packages for different destinations, the packages must of course be sorted and handled separately. Machinery can unload these from the team as well, but must then leave them for weighing, sorting, etc.

67 It seems probable that it would be advantageous to have a freight house so arranged that a certain portion of it is assigned for the handling of each of these classes of freight deliveries. While there is a multitude of variations in types of loads between the two extreme types mentioned, it would not be difficult to determine into what division of the freight shed the load should go, the distinction between loads being the amount of classification and sorting required. A practical freight house arrangement would be to have two floors, the ground floor for the loads requiring the least, the upper floor for the loads requiring the most handling. In this way the drivers of teams can go to the platforms at any vacant space the railroad employees classifying the load and the goods taken to the proper floor. It is probable that the floor for handling the miscellaneous freight could be provided with special machinery for sorting according to destination. Some of the appliances could probably be of an automatic type and hand trucking practically eliminated.

68 A similar method of handling inbound freight could be adopted and its operation facilitated, since in unloading cars a more intelligent arrangement of loads for the different station floors could be made than could be expected in the case of team delivery.

69 Thus far we have been considering only L. C. L. freight. It is by far the most expensive to handle and comprises about 40 per cent of the total freight handled. It is, however, the freight for which additional terminal capacity is badly needed.

70 The balance of the freight with which we are concerned is the team-track freight, goods which are handled in car-load lots and delivered to or removed from the car floors direct by teams. The cost to the railroad in loading or unloading this class of freight is comparatively small, about five cents per ton. In spite of this low cost the

application of machinery to handle this merchandise would prove of value. Some of this freight is of great bulk and weight and much time and labor is required to load and unload it. Special overhead tracks, capable of carrying heavy loads, can be used for this service and transporting machines and hoists of large capacity provided. Any device that will hasten the work at the team tracks will not only reduce the costs but the car detention as well. This car detention is an important matter as shown by the daily earning capacity ($3 per day) a car is quoted as having.

REDUCTION IN HANDLING COSTS

71 A fair estimate of the average load of a car is 45,000 lb., 22½ tons. The cost of handling this freight on the team tracks is now five cents per ton, $1.12½ per car. If inbound L. C. L. freight can be unloaded for ten cents per ton, and we believe it can, it would cost the railroad only $1.12½ more per car to handle much of the present team freight through the freight sheds as in the case of L.C.L. freight. This car could then be unloaded and reloaded in a day, a saving at least of one day, as two days are usually allowed for unloading before demurrage is charged, a direct saving to the railroad company of $1.87½ on each car so handled, and a storage charge can be substituted for the demurrage charge. A saving might even be effected on outbound team freight by treating it as house freight for in so handling what possible of the in and outbound team freight much switching, coupling, and uncoupling might be avoided.

72 In discussing the application of machinery to freight handling at railway terminals I have endeavored to make clear that an important reduction in handling costs is possible and that a material increase in the capacity of the present terminals can be provided without the purchase of large amount of adjacent land. I have endeavored to show how these results will have an important effect on the rates and income of the road as well as on its efficiency.

73 The general lines of development toward accomplishing these results have been pointed out and some of the leading reasons for working along these lines have been indicated. Further than this it is impossible to go in this paper. The amount of detail involved in any one phase of the subject will, I believe, be appreciated and it will also be realized that each terminal presents a different problem for solution as any proposed application of machinery must take into consideration in a greater or less degree practically every operation now carried on at the terminal under study.

STEAMSHIP TERMINALS

74 Turning now to steamship or water-borne freight terminals we find the same conditions of too great cost in handling goods, and too little space for the present traffic without even considering the future. The congestion present at a busy pier and the long delays experienced in delivering or receiving shipments is well known. The manager of a large teaming company in New York told me not long ago that a wait of two or three hours at the pier was not unusual and he had known of instances where a team had waited an entire day and at the end came away without its load.

75 The excessive costs of handling freight form an important part of the total costs as in railway transportation. The lack of sufficient capacity for handling the merchandise together with the slowness of manual handling, made slower still by the congestion and consequent rehandling, causes the delay.

76 Speed in loading and unloading vessels is of the greatest importance for differing from railway transporation the vehicle for carrying freight is one large unit, and all goods must wait until the last box is loaded. The motive power also lies idle during this wait. The motive power in railway transportation is in small units, all of which can practically be in use while cars are being loaded. The interest on the large investment represented by a modern steamship, while idle in the dock a day or so, often is an important factor in the profits of a trip. The steamship terminal differs from a railway terminal in that it is necessarily of less area, and a combination terminal as well. Over the same pier floor is handled all classes of inbound, outbound and transfer freight at the same time.

77 In the use of machinery at docks this country is far behind Europe. All large ports of Great Britain and of the Continent are well supplied with cranes of one sort or another; some ordinary pillar cranes, other movable cranes along tracks parallel with the pier. Such apparatus, however, does not constitute a true mechanical freight handling equipment nor does it perform the operations required of such an installation. Its horizontal transporting movement is rather limited and does not reach inside the sheds. The use of hand trucks at these ports is still practiced extensively.

78 It has been the custom recently to attribute the great efficiency of these ports and their lower costs of freight handling to the handling machinery there installed. The cranes principally serve to hoist or to lower loads into the ship's hold, which is done in this country by

the ship's tackle. Unless these goods are taken direct from railway cars or placed at once on cars or teams they must be taken away from or delivered to the cranes by hand trucks.

79 The difference in cost of unloading freight at San Francisco and at Hamburg is only about ten cents per ton, taking the average of all goods handled at Hamburg. San Francisco has practically no machinery and Hamburg an ample supply of modern cranes. Labor is much cheaper at Hamburg, but even this is not the main advantage: 62 per cent of all freight entering the port of Hamburg does not pass over the piers at all. The vessels tie up at moorings in the harbor and transfer their load to so-called Rhine boats, placed alongside, hoisting and lowering with the ship's tackle—the cheapest possible way of transfering merchandise.

80 At the water terminal the methods of loading are practically two in number: (*a*) direct transference to vessel from other water craft, railway cars or teams; (*b*) delivery of goods to pier and later transference to vessel. In this country the second method is generally used, direct transference being practically only from lighters used in a transfer of freight from another terminal. The usual operation, therefore, involves a large amount of handling, and much moving of small loads on trucks. Goods received at the pier are transferred to hand trucks, taken to the scales or else measured, then moved to some predetermined location and removed from trucks to be again loaded and trucked to a point where the ship's hoist can reach the load which is then lowered into the hold. With the substitution of transporting machines much greater loads can be moved from the vehicle delivering and at much greater speeds, taken over track scales and automatically weighed, moving on to the location desired or direct to the ship's hatch and immediately lowered into the hold. The elimination of manual labor is entire except in removing from cars or teams to the carrier and if in the latter case the merchandise is loaded on flatboards placed on the bed of the wagons, even this handling can be done away with.

81 The method of unloading may be either by, (*a*) direct transference to the vehicle which will move it from the pier or dock, or (*b*) direct discharge to the pier and later reloading to boat, railway car or team. In the case of coastwise traffic either method may be adopted. On the other hand cargoes from foreign ports must be handled by the second method because of the custom inspection. The advantages of employing transporting machines in unloading is apparent when contrasted with methods now in use.

82 The planning of overhead trackage for a water terminal is a simpler problem than devising one for a railway terminal, since while it must serve the entire area of the pier shed as in a freight station it need extend outside only far enough to reach the holds of the vessel. Instead of the outside trackage being designed to allow for delivery or reception of goods from a hundred or more points, the only parts necessary to be reached are the hatches of the vessel, few in number. The direct trackage for reaching the hatches must be movable in a line parallel with the pier, and so arranged that they may be entered from any portion of a permanent track forming a loop or a series of intercommunicating loops one side of which is outside of the shed.

83 Steamship freight is generally of larger bulk and greater weight than railroad L.C.L. freight and necessarily heavier trackage and more powerful transporting machines and hoists must be provided. The consignments, however, are usually larger in quantity and much less sorting and classification is necessary, conditions favorable to the maximum elimination of hand labor. Rehandling by manual labor could practically be done away with and if a direct transference between vessels and other transporting vehicles were made possible, the mechanical rehandling could be eliminated, since the transporting machine can hoist the load from the hold, carry it to the car or team and deposit it thereon. If necessary to deposit load on shed floor it can later pick it up without further rehandling and transport it to car or team or to vessel and lower it into the hold. The present cost of loading and unloading could be greatly reduced and the capacity of the terminal increased by the handling of larger unit loads at greater speeds. The capacity could be further increased by a redesign of the terminal.

84 With a transporting machine stationed on the pier itself, doing the hoisting and lowering of loads, the variation of level due to tides could be ignored since the cost of hoisting goods a few additional feet has no material effect on costs or time. Upper stories could then be utilized to advantage. As a rule a second floor is used only for warehouse purposes with the result that all is confusion on the pier floor, due to wagons both receiving and delivering goods. In many cases the pier floor is divided longitudinally into two portions by a pit down the center in which are placed cars for loading or unloading. Communication between these two platforms is maintained through the cars, and, if there is more than one line of them, by "spotting" them or by movable bridges.

85 It is suggested in the first place that no teams be allowed on the pier floor. The loads could be received or delivered at the end of the pier by the transporting machine and the space required for the teams could be utilized for other purposes. It is also suggested that each pier shed be of two floors at least, the upper floor being better adapted for incoming merchandise, since the customs officials will then have the goods on a floor apart from everything. It is evidently as easy to transfer goods to this floor from the ship or to deliver them again to teams or cars as from the first floor. Cars to be loaded can be placed on tracks on the pier between the shed and the pier edge. The lower floor could then be reserved for outgoing freight, and tracks provided for cars to be unloaded. If desired these cars could be easily loaded through hatches in the floor of the second story. As the transporting machinery would operate on overhead tracks the cars inside or outside the shed would offer no obstruction.

86 It is claimed that the cause of the decline in water transportation is due to the limited facilities for receiving and delivering the goods as well as the costly delays at the terminals. If the installation of machinery and the redesign of terminals can obviate these objections will not both shipper and carrier be the gainers?

87 In concluding the writer realizes that the subject has been treated in a general manner only. The problem is a broad one and consists not merely in the installation of certain machinery, but in the study of the changes such an innovation will make in the entire operation of the transportation system as well as the effects on costs, rates and revenue. It is not simply the adaptation of an overhead, electrically-operated carrier system to the present arrangement of terminals, but rather a redesign of the terminals and a radical change in methods of carrying on the terminal business.

88 In solving this problem let there first be a realization of what changes mechanical freight handling might make possible and then abandoning all old ideas and practices to take up the subject as an entirely new problem and work out the solution unhampered by tradition and prejudice. The subject deserves careful study and investigation. Every transportation company could afford, considering the economies that will be effected, to establish a separate department to work out this problem or to employ outside expert services for the purpose. The scope of such investigation and application is not limited to the mechanical and electrical features involved, but requires the services of men also familiar with all phases of the practical transportation problem.

STRESSES IN TUBES

By Prof. Reid T. Stewart

ABSTRACT OF PAPER

This investigation shows that the stresses in the wall of a tube exposed to external fluid pressure are of the same character as those in a column having ends fixed in direction.

Using the experimental results obtained by the author for the collapsing pressures of commercial steel tubing, 3 to 12 in. in diameter, he has derived equivalent column formulae upon the assumption that the circumferential stress in a tubular annulus subjected to external fluid pressure is theoretically the same as in a straight column, with fixed ends, whose length is one-half the mean circumference of the tubular annulus.

These formulae are

$$S = 42{,}640 - 127.4\,\frac{l}{r} \quad \text{.....(K)}$$

$$S = 708{,}000{,}000\left(\frac{r}{l}\right)^2 \quad \text{.....(L)}$$

formula (K) being for values of $\frac{l}{r}$ less than 230, while (L) is for values greater than this; where S represents the axial load on column, in lb. per sq. in., and the length of the column divided by least radius of gyration, both in the same unit.

STRESSES IN TUBES

AN INVESTIGATION SHOWING THAT THE STRESSES IN THE WALL OF A TUBE EXPOSED TO AN EXTERNAL FLUID PRESSURE ARE OF THE SAME CHARACTER AS THOSE IN A COLUMN HAVING FIXED ENDS

By Prof. Reid T. Stewart, Pittsburg, Pa.

Member of the Society

While engaged in planning a series of collapsing tests on commercial lap-welded steel tubing, the principal results of which are recorded in the Transactions of the Society,[1] the writer made a theoretical investigation of the stresses in the wall of a tube exposed to external fluid pressure. It was thought that the results of this theoretical investigation would aid in conducting the experiments on a more scientific basis and also serve to simplify the working up of results. The writer was led to believe that an annulus near the middle of a long tube exposed to external fluid pressure is subjected to the same kind of stress that exists in a column whose ends are fixed in direction when loaded axially. The following is a brief synopsis of this investigation, together with a comparison of the results obtained by the use of these new column formulae with the results of actual tests of columns and struts having ends fixed in direction.

2 *Apparent Theoretical Stresses in the Wall of a Tube Exposed to External Fluid Pressure.* Fig. 1 represents an annulus, 1 in. long, located near the middle of a long tube that is perfectly circular in cross section. Let p represent the external fluid pressure in lb. per sq. in. and T the resulting tangential stress in the wall due to this fluid pressure. Now if δa represents, in angular measure, an increment of the circumference of this annulus, then an increment of the area exposed to the external fluid pressure will be $\frac{1}{2} d\ \delta a$. The

[1] Vol. 27, pp. 730–822.

The American Society of Mechanical Engineers, 29 West 39th Street New York. All papers are subject to revision.

normal pressure on this increment of area will be $\frac{1}{2} p\, d\, \delta a$, and the component of this pressure parallel to the line of action of the tangential stress T will be $\frac{1}{2}\ p\ d\ \sin a\ \delta a$. Therefore the tangential stress

$$T = \tfrac{1}{2} \int_0^{\pi} \tfrac{1}{2}\ p\ d\ \sin a\ \delta a = \tfrac{1}{2}\ pd \ldots\ldots\ldots\ldots [1]$$

Since the tube is assumed to be perfectly circular in cross section and of uniform thickness, this formula shows: (*a*) that the circumferential stress in all parts of any annulus of a tube exposed to an external fluid pressure is constant; and (*b*) that this constant circumferential stress per in. length of tube equals the fluid pressure in lb. per sq. in. multiplied by one-half the outside diameter in ins.

3 *Apparent Stresses in a Tube Annulus Compared with those in a Column or Strut.* Fig. 2 shows one-half of a tube annulus with the

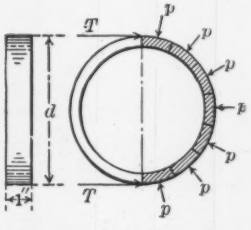


FIG. 1 ANNULUS OF UNIT LENGTH AT THE MIDDLE OF A LONG CIRCULAR TUBE

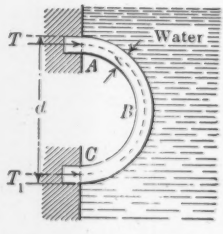


FIG. 2 HALF ANNULUS WITH FIXED ENDS

ends fixed in direction, the outside surface of the half annulus being exposed to a fluid pressure. Evidently the laws above deduced for the complete annulus apply without modification to the half annulus when its ends are fixed in direction, at the same time being free either to recede or to approach each other. All portions of this half annulus, then, are subjected to the compressive stress T (Formula 1) which acts circumferentially in the direction ABC. Opposing this, of course, is the equal circumferential stress T_1, acting in the direction CBA. By straightening the half annulus (Fig. 2) so as to bring A, B and C into the same straight line, the column or strut shown in Fig. 3 will result. It is evident that the forces T and T_1 are each rotated by this action through 90 deg. This shows that the theoretical stresses in a tubular half annulus are identical with those of the column having ends fixed in direction, when the length of the column equals the

mean semicircumference of the annulus, the two, of course, having the same cross section.

4 It will become evident from a comparison of Figs. 4 and 5 that we should take for the length of a column having fixed ends, the half circumference of an annulus located near the middle of a long tube exposed to an external fluid pressure. Fig. 4 shows the ideal collapse section for all the long tubes tested. It will be observed that the tangents to the annulus at both the highest and lowest points before collapse, as shown by the dotted lines, are precisely parallel to the tangents at the same points after collapse. In other words, these portions of the annulus while undergoing deformation remain fixed in direction. Comparing this with Fig. 5, which shows the most

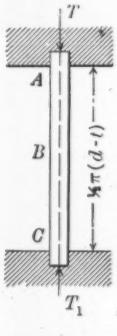


Fig. 3

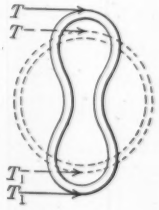


Fig. 4

Fig. 5

Fig. 3 Strut Representing Half Annulus Straightened
Fig. 4 Ideal Collapse Section for Long Tubes
Fig. 5 Most Probable Manner of Column Failure

probable manner of buckling of a long column having fixed ends, it will be seen that the two are identical as regards apparent stresses for the conditions above stated, namely, when the annulus is perfectly circular and of uniform cross section, the length of the column with fixed ends being equal to the mean half circumference of the annulus.

5 As the tube annulus departs from the circular form, while failing under fluid collapsing pressure, new stresses arise which have no counterpart in the equivalent column. An investigation has shown that these stresses are slight for small departures from roundness, so that for commercial tubing exposed to external fluid pressure the stresses are substantially the same as those in an equivalent column as illustrated above.

6 *The Author's Formula [B] for the Collapsing Pressures of Steel Tubes Reduced to an Equivalent Column Formula.* In order that he might be able to test the accuracy of the above theoretical deductions, the author has transformed his formula [*B*] for the collapsing pressures of lap-welded bessemer steel tubes[2] so that it may be used for calculating the crippling strength of columns or struts with fixed ends. This transformation was effected as follows:

7 Referring to Figs. 2 and 3, which represent respectively a half annulus of the tube and its equivalent column or strut, it is evident that the length of the equivalent column will be

$$l = \frac{\pi}{2}(d-t) \text{ or, } \frac{d}{t} = \frac{2l}{\pi t} + 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where d and t represent respectively the outside diameter and the thickness of the wall of the tube in in. and π the ratio of the circumference to the diameter of a circle. Since $t = 3.464\ r$, where r equals the radius of gyration of cross section of the annulus and of its equivalent columns,

$$\frac{d}{t} = \frac{2l}{3.464\,\pi r} + 1 = 0.1838\,\frac{l}{r} + 1 \quad \ldots\ldots\ldots [3]$$

$$p = \frac{2T}{d} = \frac{2tS}{d} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [4]$$

where p represents the external fluid pressure in lb. per sq. in., T the total circumferential stress in the wall of the annulus 1 in. long, and S the total circumferential stress per sq. in. of cross section, both being expressed in lb. Also, t and d, as before, represent respectively the thickness of the wall and the outside diameter of the tube, in in. Formula [*B*], using the same notation as before, is

$$p = 86{,}670\,\frac{t}{d} - 1386 \quad \ldots\ldots\ldots\ldots\ldots\ldots [B]$$

By equating the second members of equations [4] and [*B*] we get

$$\frac{2tS}{d} = 86{,}670\,\frac{t}{d} - 1386$$

from which

$$S = 43{,}335 - 693\,\frac{d}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

[2] Trans.Am.Soc.M.E., vol. 27, p. 793.

By substituting the value of $\frac{d}{t}$ from equation [3] we get

$$S = 42{,}640 - 127.4\frac{l}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [K]$$

8 This is a formula for the crippling strength of a column with fixed ends, as derived directly from formula [*B*] for the collapsing pressures of long tubes that are exposed to external fluid pressures. In this formula, S represents the axial load on the column in lb. per sq. in. of cross section, while $\frac{l}{r}$ represents the slenderness ratio, or the length of column divided by the least radius of gyration of cross section, both being expressed in the same lineal unit.

9 Since formula [*B*] is applicable to values of thickness divided by outside diameter $\left(\frac{t}{d}\right)$ greater than 0.023, formula [*K*] should be applicable to values of length of columns divided by least radius of gyration, $\frac{l}{r}$, less than

$$\frac{\frac{\pi}{2}(d-t)}{\frac{t}{3.464}} = 1.732\ \pi\left(\frac{d}{t} - 1\right) = 1.732\ \pi\left(\frac{1}{0.023} - 1\right) = 230$$

Note that formula [*G*][3] is tangent to formula [*B*] at $\frac{t}{d} = 0.024$, which gives a slenderness ratio $\left(\frac{l}{r}\right)$ at point of tangency of 221, which latter should therefore be the true limiting value of r for formula [*K*] when used in connection with formula [*L*] as given below.

10 *The Author's Formula* [*G*] *for the Collapsing Pressures of Steel Tubes Reduced to an Equivalent Column Formula.* In a manner similar to the above derivation of formula [*K*] the author's formula [*G*] has been transformed into an equivalent formula for the crippling strength of long columns or struts. Using the same notation as before collapse formula [*G*] which is applicable[3] to values of $\frac{t}{d}$ less than 0.024, is

$$p = 50{,}210{,}000\left(\frac{t}{d}\right)^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots [G]$$

[3] Trans. Am.Soc.M.E., vol. 27, p. 795.

and its equivalent column formula, derived in a similar manner, is

$$S = 25{,}105{,}000 \left(\frac{1}{0.1838 \frac{l}{r} + 1} \right)^2 \quad \ldots\ldots\ldots\ldots [6]$$

which is applicable to values of $\frac{l}{r}$ greater than 221, as stated above. This somewhat complex formula is represented with sufficient accuracy for all practical purposes by the following simple formula:

$$S = \frac{708{,}000{,}000}{\left(\frac{l}{r}\right)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [L]$$

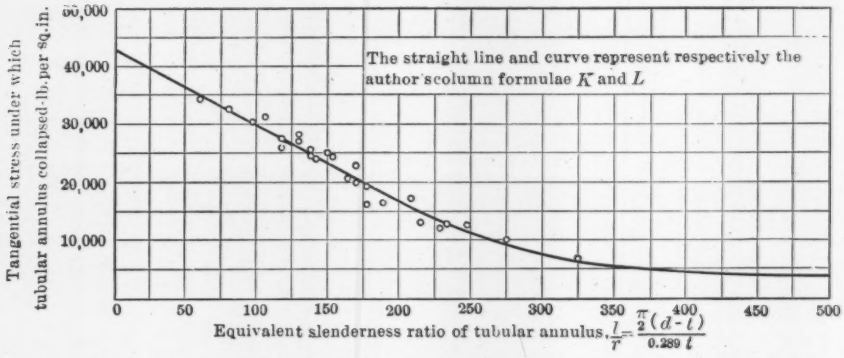


FIG. 6 PLOTTED RESULTS OF THE AUTHOR'S EXPERIMENTS ON COLLAPSING PRESSURES OF LAP-WELDED STEEL TUBES

where S as before, represents the axial load on the column in lb. per sq. in. of cross section, and $\frac{l}{r}$ the length divided by least radius of gyration of the column, both being expressed in the same lineal unit. This formula applies only to columns having both ends fixed in direction and for values of $\frac{l}{r}$ greater than 221.

11 *Verification of the Author's Column Formulae [K] and [L] by Comparison with Results of Tests on Columns.* In order to show that the new column formulae given in this paper are applicable to commercial shapes and annular sections when used as columns with ends fixed in direction, Figs. 6 and 7 were prepared. The only tests on

commercial struts and columns with fixed ends known to the writer are those made by James Christie on wrought-iron struts,[4] and those made at the Watertown Arsenal[5] in 1909.

12 The average physical properties of the iron in the struts tested by Mr. Christie were

Tensile strength, lb. per sq. in.	49,000
Elastic limit, lb. per sq. in.	32,000
Elongation in 8 in., per cent	18

while those of the steel constituting the lap-welded tubes tested by the writer and at the Watertown Arsenal were

Tensile strength, lb. per sq. in.	58,000
Yield point, lb. per sq. in.	37,000
Elongation in 8 in., per cent	22

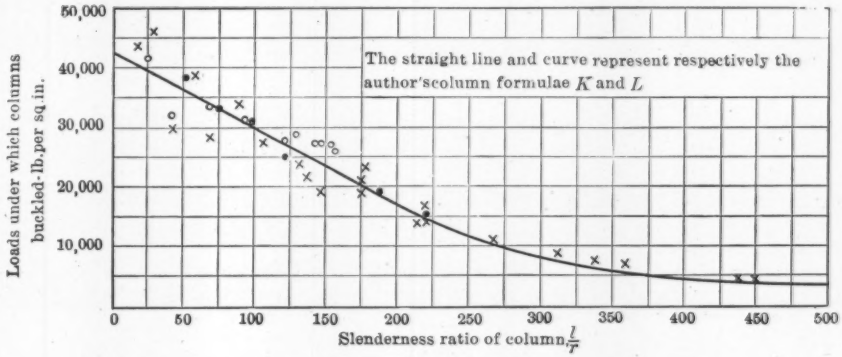


FIG. 7 PLOTTED RESULTS OF VARIOUS COLUMN EXPERIMENTS

(x) indicates plotted results of Christie's experiments on wrought-iron angles ranging from 4 in. × 4 in. × ⅜ in. to 1 in. × 1 in. × ½ in., with fixed ends.
(•) indicates plotted results of Christie's experiments on lap-welded wrought-iron tubes used as columns with fixed (flanged) ends.
(o) indicates plotted results of Watertown Arsenal experiments on lap-welded steel tubes, 5 in. outside diameter, used as columns with fixed ends.

13 These data show that the material of the angles and tubes tested by Mr. Christie as compared with those of the tubes tested by the writer and at the Watertown Arsenal had average physical properties less by 15 per cent in tensile strength, 13 per cent in elastic limit, and probably less that 10 per cent in modulus of elasticity, or rigidity factor. It should be remembered while comparing the results

[4] Trans. Am.Soc.C.E., 1884, p. 117.
[5] Proceedings, American Society for Testing Materials, 1909, p. 413.

of these experiments, that these differences in the physical properties of the materials, which it will be noticed are comparatively small, will be more or less offset for two reasons: (*a*) the tubular annulus at the point of failure varies somewhat more from being truly circular than does the strut from being truly straight; and (*b*) there is a small bending moment on the wall of the tubular annulus directly due to the action of the external fluid pressure on an annulus that is slightly out of round, for which there is no counterpart in the equivalent column.

14 Fig. 6 represents the plotted values of the results of the writer's experiments on the collapsing pressures of lap-welded steel tubes. These results are plotted to a horizontal scale representing the equivalent slenderness ratio of the semi-tubular annulus considered as being under the same conditions of stress as a column with ends fixed in direction (Figs. 2, 3 and 4). Since the mean semicircumference of the tube annulus equals $\frac{\pi}{2}(d-t)$ and the radius of gyration of the section equals $0.289t$, this slenderness ratio will be $\frac{l}{r} = \frac{\frac{\pi}{2}(d-t)}{0.289\,t}$. The vertical scale represents the apparent tangential stress T (Fig. 2), under which the tubular annulus actually failed.

15 Fig. 6 represents the plotted values of the group averages of Series 2 of the author's experiments on the collapsing pressures of lap-welded steel tubes, 3 to $12\frac{3}{4}$ in. outside diameter.[6] The straight portion of the line represents the writer's column formula [*K*] plotted to the same scales, while the curved portion similarly represents column formula [*L*].

16 Fig. 7 represents the plotted values of all results of tests on commercial struts and columns with ends fixed in direction known to the writer. It should be noted here that practically all tests of commercial columns and struts have been conducted under the condition of flat, pin, or round ends.

[6] Trans., Am.Soc.M.E., vol. 27, pp. 787-802.

THE ASSEMBLY OF SMALL INTERCHANGEABLE PARTS

By John Calder

ABSTRACT OF PAPER

The direct labor cost of assembling small interchangeable parts is a comparatively large item in light mechanical engineering and repetition work.

Economical production demands that easy assembly be kept in view at all stages from the design of a mechanism and through the tooling and shop processes to the delivery of the unit parts to the assembler.

The paper analyzes and illustrates all the elements which should enter into the producer's calculations and outlines the works organization necessary to secure the rapid and economical production of suitable unit papers. It describes the results obtained in the assembly of given pieces and illustrates the simple apparatus used and the place that preliminary time and motion study has in assuring the shop shall, from the first, begin operating upon the assembly of the mechanism under the most economical conditions.

THE ASSEMBLY OF SMALL INTERCHANGEABLE PARTS

By JOHN CALDER, ILION, N. Y.

Member of the Society

In the branches of mechanical engineering and manufacturing devoted to complicated and highly finished business and domestic appliances, as distinguished from the many simpler and rougher forms of hardware, the direct labor costs of assembling the numerous small interchangeable parts are very important items. They often considerably exceed the whole cost of the material and the expense incurred upon them is much more within the control of the management.

2 Long before any proposals were made towards the general modification of the day-rate system of labor reward in most plants, the large industries mentioned had been driven by necessity to cheapen and intensify production by methods more or less systematic.

3 The movement in mechanical engineering in recent years towards scientific time study of labor tasks owes much to the proceedings of the Society, particularly to the contributions and well-considered generalizations of Fred. W. Taylor and H. L. Gantt. It is now fully realized that the scientific principles advocated are simply common sense organized to a very high degree and that what is needed is not so much expert advice and staff and equipment changes as a firm realization of the possibilities by an efficient management and the ability successfully to inoculate the existing organization with like optimism.

4 This movement found many interchangeable parts industries in a very favorable position to profit by it and not a few of them have resumed the economical evolution of their processes and labor methods along the new lines at a rapid pace after a period of more or less stagna-

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. All papers are subject to revision.

tion. They have accomplished this in many cases by adopting the new principles in full, but using the existing staffs and appliances and dispensing with the capital outlays and outside expert aid which is sometimes absolutely necessary in machine shops when the change of system is very marked.

5 Table 1 is a typical organization chart for a works employing several thousand people in the interchangeable parts industry when the great bulk of the parts production is assembled into finely adjusted machines. It is the purpose of this paper to outline and illustrate briefly the principles upon which the parts assembly department is conducted, but they are equally applicable to all the manufacturing branches indicated on the chart.

6 Economical parts assembly implies, among other things, the securing for such operations in shop practice at the initial stages in the history of a new part of

a The highest assembly speed and

b The prescribed quality of work; neither more nor less.

7 If these conditions are fulfilled, the best economy will be most quickly attained when

c The classes of labor available are properly selected, graded and trained.

8 Economical assembly is sometimes attained by indirection, after a long drawn-out and intermittent process of elimination, trials and modifications based upon rough occasional observations by foremen and others of ordinary workers in the shop. This course is costly, uncertain and slow, and early expensive and inefficient conditions are apt to be perpetuated.

9 Starting with small interchangeable parts of the most practicable form, the management of such a works is in a position to determine for itself, without the guesswork sometimes neccessary in complicated machine tool operations, the best assembly arrangements of apparatus and of labor. Any plant doing light repetition work in quantities can afford to devote a small inexpensive department entirely to this task and to cease the guessing methods, whether aided by premiums or not, which often do duty for painstaking time study and efficient initial criticism of apparatus and routine.

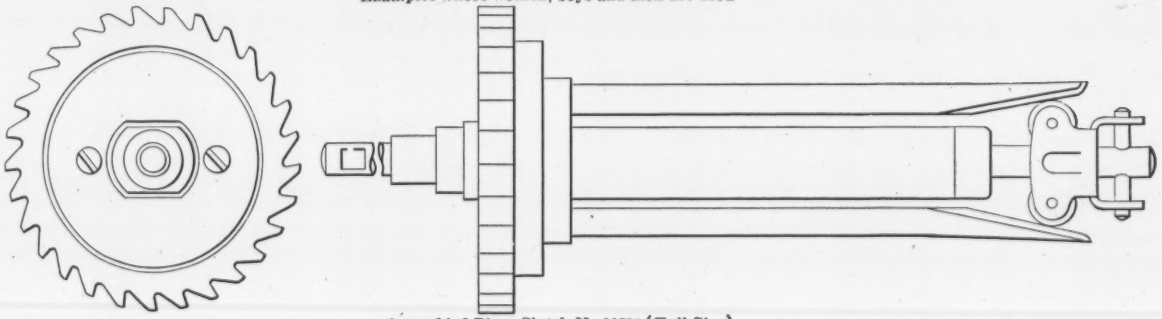
10 Certain preliminary precautions and results in the machine shop and other departments producing the unit pieces to be assembled are necessary, such as

d The designing of the form of the part with quick assembling in view.

TABLE 1 ORGANIZATION OF LARGE WORKS MAKING AND ASSEMBLING SMALL INTERCHANGEABLE PARTS

- MANAGER
  - EXECUTIVE DEPARTMENTS
    - GENERAL OFFICE
      - Correspondence
      - Cashier and Bookkeeper
      - Industrial Betterments
      - Time Records and Payroll
      - Rate Records
      - Costing and Inventories
      - Works "Bulletin"
      - Suggestion System
      - Foremen's Club House
      - Works Band
      - First Aid
    - PURCHASING
      - Purchasing Raw Material and Supplies
      - Receiving Clerk, Teams, R R. Siding
      - Raw Material and Supply Stores
    - FINISHED PARTS AND PRODUCTION ORDERS
      - Finished Parts Stock Room
      - Issues all Production Orders for Parts
      - Issues all Parts for Machine Manufacture
    - SHIPPING
      - Stock of Finished Machines, Packing Room
      - Shipping and Billing Machine and Part Orders
    - WORKS ENGINEERING
      - Light, Heat, Power, Ventilation
      - Millwrights, Electricians, Plumbers
      - Fire Corps, Watchmen, Yard Labor
  - MANUFACTURING DEPARTMENTS Superintendent
    - MANUFACTURE OF PARTS Asst. Supt. and Foremen
      - Pattern Shop
      - Brass Foundry
      - Iron Foundry
      - Japanning
      - Tinsmiths
      - Drop Forging
      - Punch and Press Work
      - Automatic and Hand Screw
      - Annealing and Hardening
      - General Grinding
      - Light Milling and Drilling
      - Cast Iron Milling and Drilling
      - Polishing
      - Plating and Buffing
      - Wood and Rubber Working
      - Assembling Compound Parts
      - Tool Designing and Model Making
      - Tool Making
      - Inspecting Parts
      - Testing Rates and Methods
    - MANUFACTURE OF MACHINES Asst. Supt. and Foremen
      - Assembling Machine Group No. 1
      - Assembling Machine Group No. 2
      - Assembling Machine Group No. 3
      - Assembling, Final Stage
      - Inspecting Machines
      - Adding Special Fixtures
      - Rebuilding Machines
      - School of Repairing

TABLE 2 DIVISION OF LABOR AND SPEED OF WORKERS IN ASSEMBLING SMALL INTERCHANGEABLE PARTS
Examples where women, boys and men are used



Assembled Piece Clutch No.31531 (Full Size)

Stage No.	Unit Parts 18 in Number Assembled in 10 Stages	Operations in Sequence	Grade of Labor	Average Time Including Stops, from Records of 100,000 Pieces	
				Min.	Sec.
1		Ream 2 holes 0.073″ in Roll Holder No.30670 on speed lathe	Women	0	7
2		Assemble roll holder No.30670 2 rolls No.30680 and 2 pins No.67640 at bench	Boys	0	45
3		Ream 1 hole 0.166″ in clutch frame No.30361 on speed lathe	Women	0	5

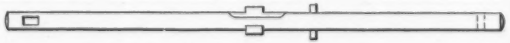
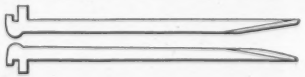
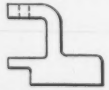
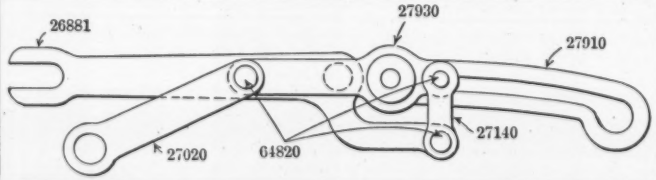
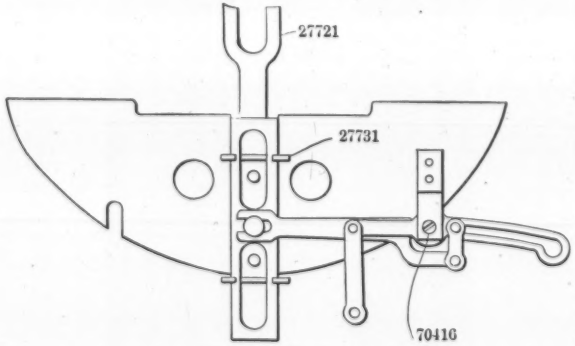
4		Tap 2 holes 0.08″–56 in clutch frame No.30361 on tapping machine	Men	0	16
5		Ream 2 holes 0.085″ and 0.059″ in shaft No.31620 on speed lathe	Women	0	10
6		Straighten shaft No.31620 on bench block	Boys	0	8
7		Put pin No.65610 in shaft No.31620 with bench fixture	Boys	0	20
8		Put in washer No.90000 and assemble tube No.31521 and spring No.67210 at bench	Men	2	24
9		Bend and gage clutch jaws No.30690 in bench vise	Men	0	31
10	See full-size sketch	Assemble clutch jaw No.30690 ratchet No.30370, frame cover No.30330, 2 screws No.70402, and roll holder comp., with pins No.64650 at bench	Men	3	52
	The direct labor cost of assembling 1 clutch No.31531 is 3.784 cents	Average time to assemble 18 unit parts to form clutch No.31531	Women Boys and Men	8	40

TABLE 3 DIVISION OF LABOR AND SPEED OF WORKERS IN ASSEMBLING SMALL INTERCHANGEABLE PARTS

Examples where men only are used

Unit Parts 15 in Number Assembled in 9 Stages	Stage No.	Operations in Sequence	Grade of Labor	Average Time Including Stops, from Records of 100,000 Pieces	
				Min.	Sec.
	1	Ream 1 hole to size 0.101″ in support bracket for ribbon driving arm No.27060 on speed lathe	Men	0	10
	2	Ream 1 hole to size 0.101″ in ribbon position adjusting arm No.27910 on speed lathe	Men	0	10
	3	Ream 1 hole to size 0.101″ in ribbon shifting arm No.27930 on speed lathe	Men	0	10
	4	Burnish adjusting arm No.27910 on bench	Men	0	12
	5	Assemble driving arm, No.26881 shifting link No.27020, connecting link No.27140, stud for adjusting arm No.27150, adjusting arm No.27910 shifting arm No.27930 and 3 rivets No.64820 on bench	Men	0	48

6	Bend and gage carrier No.27721 to bench fixture	Men	1	12



Assembled Piece No.27710

(Half Size)

7	Assemble support bracket No.27060 and guide No.27731 with 2 screws No.74410 on bench	Men	1	2
8	Fit carrier No.27721 and guide No.27731 on bench	Men	1	36
9	Final assembling of riveted links with carrier No.27721 and guide No.27731 with screw No.70416, on bench	Men	1	58
The direct labor cost of assembling No.27710 is 4.195 cents	Average time to assemble 15 unit parts into 1 carrier guide and driving arm No.27710	Men	8	18

TABLE 4 DIVISION OF LABOR AND SPEED OF WORKERS IN ASSEMBLING SMALL INTERCHANGEABLE PARTS

Examples where women only are used

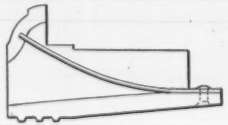
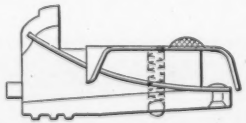
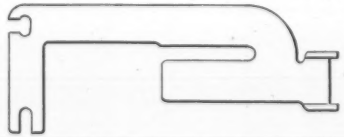
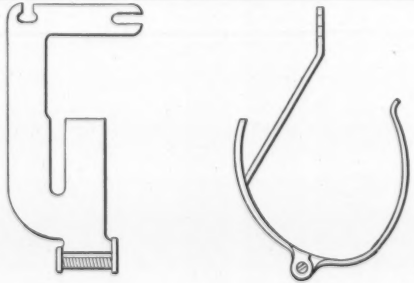
Unit Parts Ten in Number Assembled in Three Stages (Full Size)	Stage No.	Operations in Sequence	Grade of Labor	Average Time Including Stops from Records of 100,000 pieces
	1	Assemble stop No.36202 and spring No.66220 with rivets No.64950 on Bradley hammer.	Women	Min. 0 Sec. 45
	2	Drive pin No.64750 in stop No.37612 on bench.	Women	0 12
	3	Assemble locating ball No.16100, spring No.67150, indicator No.36180 with screws No.70000 on bench.	Women	0 36
	The direct labor cost of assembling one margin stop No.37612 is 4 mills	Average time to assemble 10 unit parts to form one margin stop No.37612	Women	2 33

TABLE 5 DIVISION OF LABOR AND SPEED OF WORKERS IN ASSEMBLING SMALL INTERCHANGEABLE PARTS

Examples where boys only are used

Unit Parts Four in Number Assembled in Two Stages	Stage No.	Operations in Sequence	Grade of Labor	Average Time Including Stops from Records of 100,000 pieces	
				Min.	Sec.
	1	Tap one hole 0.100″-48 in support No.26571 on tapping machine.	Boys	0	6
 (Half Size)	2	Assemble support No.26571, tension finger No.26580, spring No.67400 with screw No.70838 and gage by weight test on bench.	Boys	1	15
		The direct labor cost of assembling one No.27520 is 6½ mills. Average time to assemble 4 unit parts to form one spool guard No.27520.	Boys	1	21

e The designing and proper maintenance of efficient tools, jigs and fixtures, working to practicable limits in the dimensions and fits.

f An efficient parts inspection service, securing in every department adherence to these limits and the rejection of all defective unit parts.

g The adoption for each unit piece of a shop routing in machine and other departments which will produce the fitting surfaces in the conditions permitting the least work in assembling. The total abolition of the file or other cutting tools at the bench should be aimed at.

11 If the foregoing conditions are observed, the speed of assembly will then depend upon

h The extent to which the division of labor is carried.

i The thoroughness of the time study of skilled demonstrators in each division, including the elimination of lost motion and the criticism of the machined unit pieces.

j The efficiency of the mechanical facilities provided by the management for aiding the work of assembly.

12 If the above ten conditions (*a* to *j* inclusive) are by suitable organization fulfilled for any new piece before it is presented to the workers in any way and the assembly work done is accepted only after passing an efficient inspection, a straight piecework system of remuneration will often be found best in the interests of employer and employee alike.

13 After such a close preliminary study and exhaustive development of the possibilities, there is no such margin remaining as obtains in the rough approximations of premium setting where the processes are often left to evolve slowly and uncertainly at the initiative of the workers and overseers alone. The employees, therefore, may well be given the whole of their gains on the prescribed standard task.

14 Tables 2 to 5 show a few examples of the division of labor and speed of workers on straight piece-work tasks in the assembly of small interchangeable parts, where all the conditions essential to the highest economy have been thoroughly and expeditiously worked out before the assembly task is presented to the manufacturing department. Table 2 gives the final arrangements as determined by the task and method department for a mechanical assembly using the labor of men, women and boys, while Tables 3, 4 and 5 are examples of three mechanical tasks performed by men, women and boys separately.

15 Owing to the minute division of labor and the elimination by careful study of all lost motion, most of the tabulated assembly stages, it will be noted, are performed in much less time than it takes to describe them. About three-quarters of a million unit pieces of several thousand varieties are handled daily on the principles laid down, passing successively through most of the 27 manufacturing departments indicated in Table 1. The total operations involve the use of about 20,000 straight piece rates, each based upon the results of exact preliminary time and method studies.

16 *Apparatus.* The course followed in attaining such results varies according to the nature of each department, but the main features are the same for all and will be sufficiently indicated, the

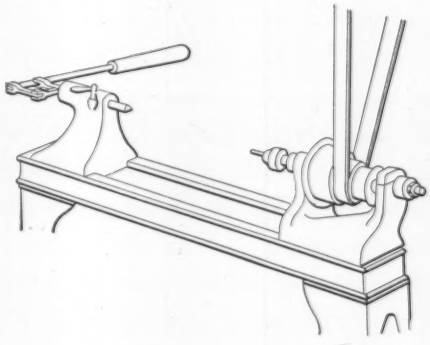


FIG. 1 POWER SPEED LATHE

writer believes, by describing the concrete parts assembly tasks of Tables 2 to 5. In addition to an ordinary bench vise, a 4-oz. hammer, a bench anvil block and screw-drivers, the rest of the tools used consist of simple machines and fixtures, and embrace the following: a power speed lathe (Fig. 1), a vertical power tapping machine (Fig. 2), a bench pin-insertion fixture (Fig. 3), a Bradley hammer (Fig. 4), a horizontal power tapping machine (Fig. 5), a bench gage fixture (Fig. 6).

17 It will be noted that the file is absent from the above list. The possession or use by any assembler of this mechanical persuader toward a fit is forbidden, unless after due cause shown and under special permit. The writer has found that such a prohibition will often throw a considerable amount of new light upon the real condi-

tion and suitability of the machined surfaces prepared in the other shops and which have passed the prescribed gage tests. The general tendency of this course is to raise the whole level of machine shop practice and to help greatly in locating more definitely for the tool designer and maker needed refinements and corrections in the jigs and fixtures, as well as in other processes.

18 *Method.* Prior to the introduction into the shops of any new assembly operations, such as those described, the prescribed apparatus, which is the best that the collective experience of superintendent, foreman and tool engineer can devise, is handed over to the time and motion study department, whose few expert employees proceed to operate with it on a manufacturing scale. They handle large quanti-

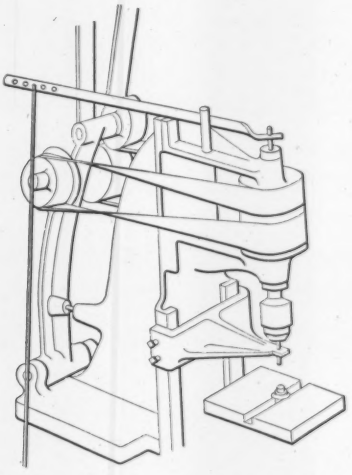


FIG. 2 VERTICAL POWER TAPPING MACHINE

ties of product which is subject to all the usual inspection tests and passes into the manufacture. In this way the cost of the time study department is reduced to a very small figure, for the working time of its experts is fully as productive as that of the shop. These few experts have been selected and organized from the ranks of ordinary employees in the works who have shown considerable versatility and the power of comparative observation. When such initial criticism of the apparatus and parts supplied as has been well taken has been put into effect, it is the duty of this department to ask and answer quickly by expert demonstrations the following questions regarding the particu-

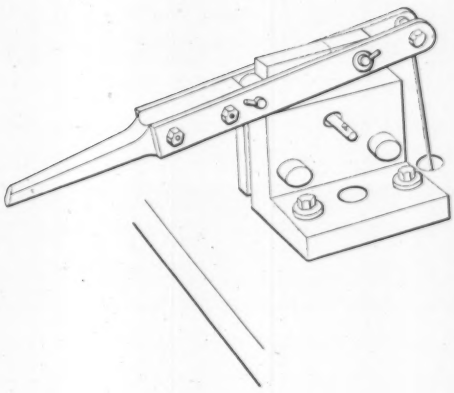


FIG. 3 BENCH PIN-INSERTION FIXTURE

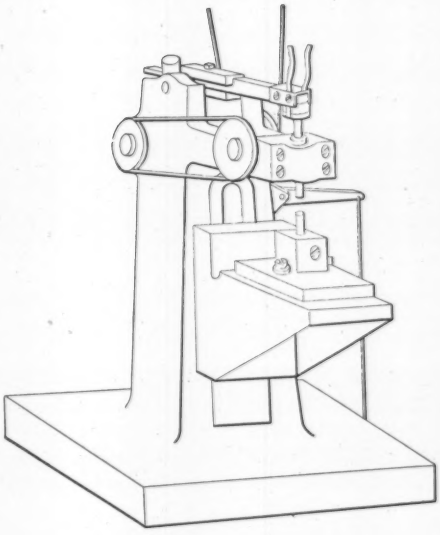


FIG. 4 BRADLEY HAMMER

lar operations cited, the motions being carefully studied as to their necessity and timed as to their duration:

a Best height and position of the seat or chair for the operator (male or female) at the bench or machine.

b Best position in front, or on right or left of operator, of the several stocks of each unit piece comprised in the assembly task.

c Best position of the hand tools and appliances which the operator has to pick up and apply and lay down again.

d The advantage, if any, which an ambidextrous operator has at any stage and the cultivation of that faculty.

e Best arrangement for bringing forward and removing the work without interrupting the assembly process.

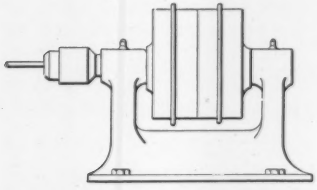


FIG. 5 HORIZONTAL POWER TAPPING MACHINE

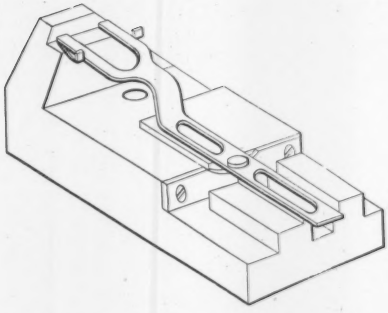


FIG. 6 BENCH GAGE FIXTURE

f Progressive time study under the best conditions of each of the movements finally decided upon as necessary and the combination of all of them on the principle of "least work."

When the possibilities are fully in view a straight piece-rate is fixed, based on these, which will give an industrious worker of average ability in each grade the normal earnings, while the exceptional operator receives the full amount of his surplus.

19 The system described in this paper, for a few tasks of one department only, is applied to all the manufacturing divisions, with details appropriate to their needs. It is also applicable in kind, if not in degree, to economising many functions in the executive division. There is but one study staff of six members for the whole works. These soon record standardized conditions for every class of manual and machine operation and their work on any new problem or revision is quickly and economically performed.

20 The writer does not favor the restriction of the ordinary shop foremen solely to productive supervision but prefers to encourage them to compete freely with the time study staff for the best result. If pains are taken to give publicity to all good suggestions adopted from foremen a surprising amount of very profitable coöperation can be obtained from them, which enhances instead of diminishing their administrative ability.

21 The system outlined here in only one class of application is profitable to employer and employee alike. It is a true conservation and indeed an intensification of capital and labor, two natural resources which need never be exhausted.

PRESSURE-RECORDING INDICATOR FOR PUNCHING MACHINERY

By Prof. Gardner C. Anthony

ABSTRACT OF PAPER

The use of an indicator for the direct recording of stresses due to punching boiler plates, under the working conditions of a boiler shop punch, is believed to be new. This paper is largely descriptive of a device for obtaining cards from an ordnance indicator applied to a pressure cylinder, which enables the operator to obtain results as easily and rapidly as is done in indicating an engine. The cards illustrated were taken under the above conditions and also with the apparatus applied to an Olsen testing machine. The latter was for the purpose of checking certain results and introducing a variety of conditions which it is proposed to investigate.

Although the number of tests so far made is insufficient for conclusive evidence, they have demonstrated the efficiency of the device as a piece of laboratory apparatus which will serve admirably for determining data relating to the following: the maximum pressures for which punching machines should be designed, the point of maximum stress in the punching of plates and other material, the effect on the maximum stress by increasing the clearance between punch and die, the advantages to be derived from the use of shearing punches, and finally, the effect of time on the flow of metal in punching.

PRESSURE-RECORDING INDICATOR FOR PUNCHING MACHINERY

By Prof. Gardner C. Anthony, Tufts College, Mass.

Member of the Society

The design of this device was assigned as the subject for a mechanical engineering thesis at Tufts College, in the endeavor to determine such values as the maximum pressures for which punching machines should be designed, the point of maximum stress in the punching of plates, the advantages to be derived from the use of shearing punches, the effect of increased clearance between punch and die on the maximum stress and the effect of time on the flow of metal in punching.

2 The apparatus was designed to enable indicator diagrams to be taken under the conditions of actual shop practice by applying the mechanism to punching machinery now in use. It was first used in May 1909, at the New England Iron Works, South Boston, where it was applied to a Bisbee-Endicott lever-type punch, for which it was designed. Tests were made on plates of $\frac{1}{4}$ in., $\frac{7}{16}$ in. and $\frac{1}{2}$ in. thickness, with punches of $\frac{1}{2}$ in., $\frac{5}{8}$ in. and $\frac{3}{4}$ in. diameter.

3 Only such tests were made at that time as were deemed necessary to demonstrate the efficiency of the apparatus, since before applying it to a series of tests it was thought desirable to compare the indicator diagrams already taken with those which might be obtained from its application to a testing machine, as illustrated in Fig. 1. This was done in June 1910, when it was applied to a 60,000-lb. Olsen testing machine. The results demonstrated the desirability of continuing the experiments on this machine, since there was but a slight variation in the cards, due to the increased time of punching, while a much greater range of speeds was possible.

4 The number of tests now made are insufficient for conclusive

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evidence concerning the problems relating to shearing stresses, but it was thought desirable to present this application of an indicator as a useful addition to recording devices for testing machines, and to give some results of tests already made for the purpose of stimulating experimental work in this direction.

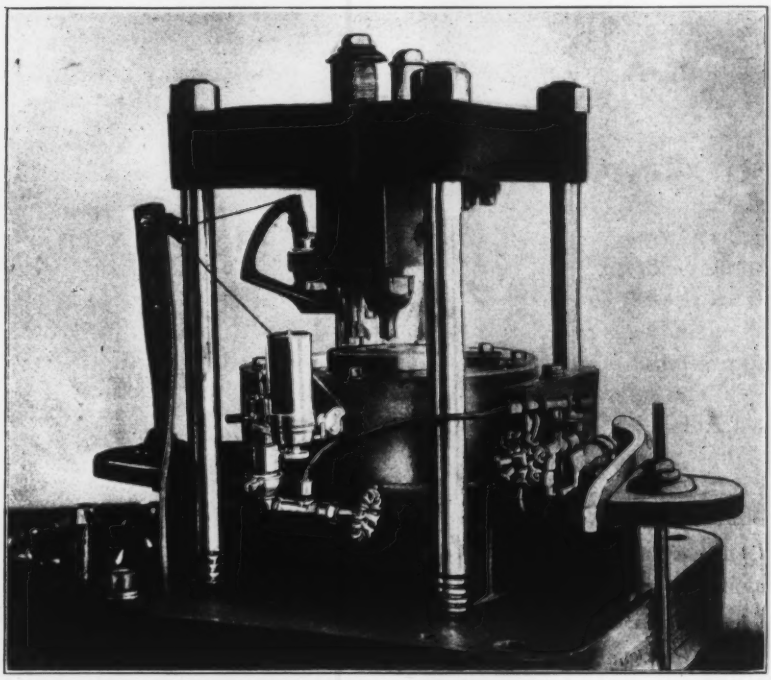


FIG. 1 PRESSURE-RECORDING APPARATUS APPLIED TO TESTING MACHINE

5 The principle employed in the design of the pressure-recording mechanism was that of the Emery testing machine, save that the hydraulic chamber communicates directly with an ordnance indicator, as in Fig. 3, which shows a cross-section of the compression cylinder with the indicator attached and the motion mechanism bolted to the crosshead of a punching machine. The die N is clamped to a piston P, which rests on a thin diaphragm D enclosing a small volume of oil, the pressure of which is recorded by the indicator. The piston has an area of 50 sq. in. and is guided by two annular steel discs fixed between

rings E and F and K and L. These serve to centralize the piston and to eliminate all frictional losses due to surface contact. The die N is held in place by an interrupted screw S, by means of which the die can be removed quickly and the burs, or punchings, removed from the space below. The diaphragm is made of sheet brass 0.007 in. thick and fitted to the grooved space G, at which place the pressure chamber is made tight by a lead packing ring. An air valve and an indicator pipe communicate with this space. The recess on the lower face of the piston serves to make the diaphragm taut by being forced into place when first under pressure, and also permanently to center the piston. The piston and die have a possible motion of 0.025 in., the limits being determined by the lower ring F and the inner flange at the bottom of the cylinder. Only a small part of this motion is

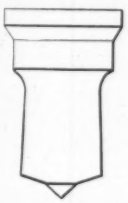


FIG. 2 TYPE OF SHEARING PUNCH USED

necessary, since the ratio of pressure piston to indicator piston is 2000 to 1.

6 Fig. 4 illustrates an oil tank, pump, gage and pipe connections to enable the operator to insure a supply of oil under slight pressure before each operation and to provide for a slight loss through leakage by the indicator piston. The general arrangement of these fixtures is more clearly shown in Fig. 1, which illustrates the mechanism applied to the Olsen testing machine.

7 The motion mechanism for indicating the travel of the punch in the plate is attached to the crosshead of the testing machine or punching machine. It consists of an arc T and a wheel R (Fig. 4), operated by a metallic band connection between the latter and the finger V, which is set in motion by contact with the plate to be punched. The indicator motion ratio is 5.5 to 1.

8 Special punches and dies were made for these tests, both flat and shearing punches being used. The latter were of the type illustrated by Fig. 2. No lubricant was used in these tests.

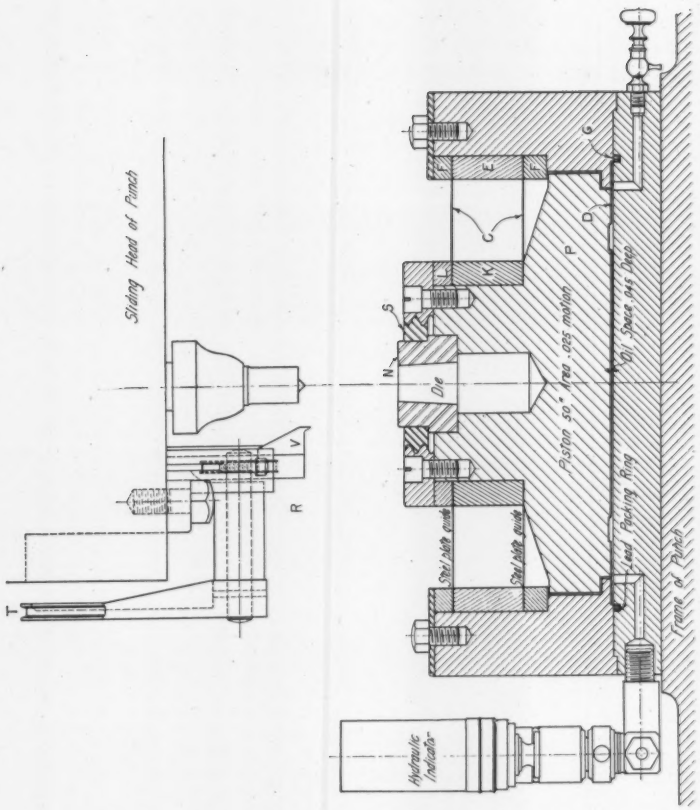


FIG. 3 SECTION THROUGH COMPRESSION CYLINDER

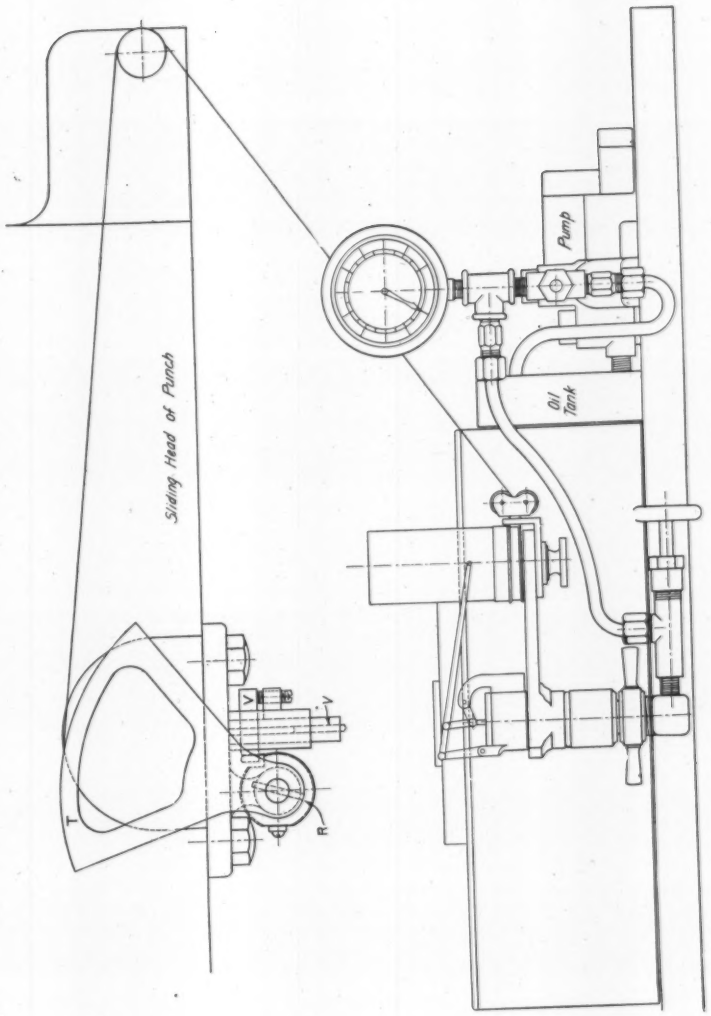
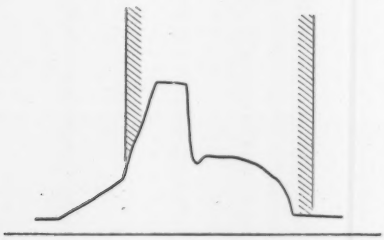
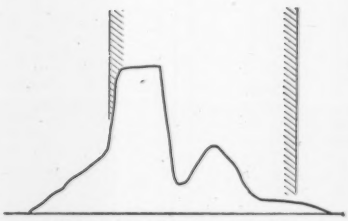


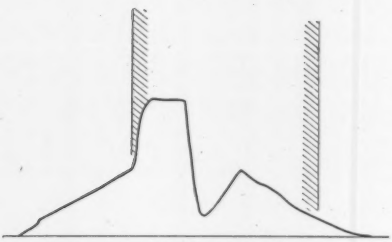
FIG. 4 DIAGRAM OF RECORDING APPARATUS



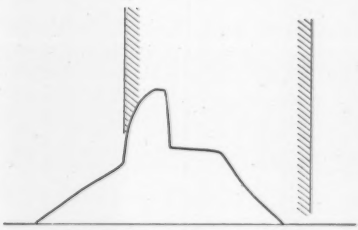
No.1 Die 0.529 Plate 0.257
Punch *F* 400-lb. Spring



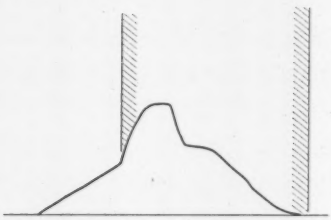
No.3 Die 0.529 Plate 0.257
Punch *F* 400-lb. Spring



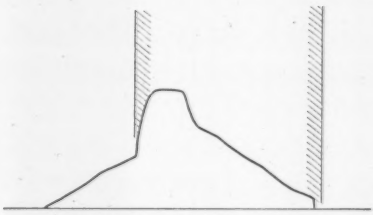
No.9 Die 0.654 Plate 0.257
Punch *F* 500-lb. Spring



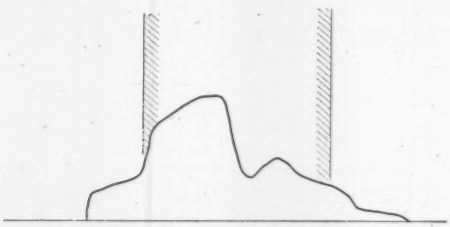
No.38 Die 0.654 Plate 0.257
Punch *F* 500-lb. Spring



No.39 Die 0.654 Plate 0.257
Punch *F* 500-lb. Spring

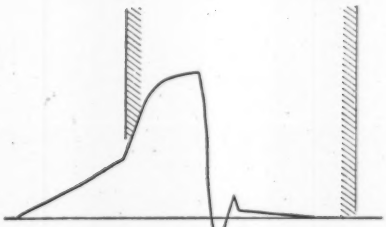


No.10 Die 0.654 Plate 0.257
Punch *F* 500-lb. Spring

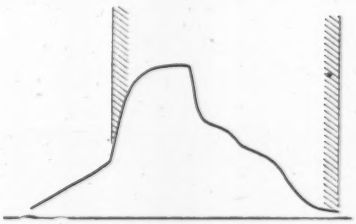


No.7 Die 0.654 Plate 0.257
Punch *S* 500-lb. Spring

FIG. 5 SPECIMEN DIAGRAMS FROM RECORDER

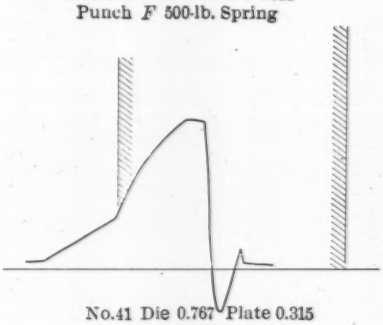


No.33 Die 0.767 Plate 0.315
Punch *F* 500-lb. Spring

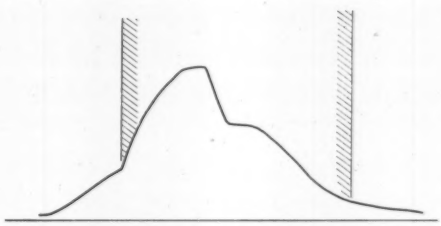


No.34 Die 0.767 Plate 0.315
Punch *F* 500-lb. Spring

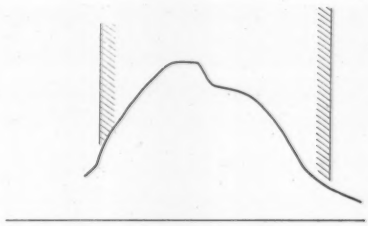
No.36 Die 0.767 Plate 0.315
Punch *F* 500-lb. Spring



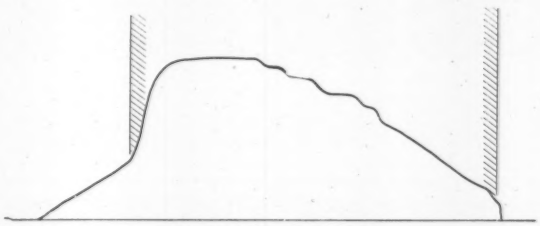
No.41 Die 0.767 Plate 0.315
Punch *S* 500-lb. Spring



No.42 Die 0.767 Plate 0.315
Punch *S* 500-lb. Spring



No.43 Die 0.767 Plate 0.315
Punch *S* 500-lb. Spring



No.19 Die 0.767 Plate 0.500
Punch *F* 890-lb. Spring

FIG. 6 SPECIMEN DIAGRAMS FROM RECORDER

9 Before taking a card, a datum line of zero pressure was drawn, after which the oil pump was used to obtain a slight pressure in the compression chamber before operating the punch. The series of diagrams shown in Figs. 5 and 6 were reproduced from indicator cards, verticals being drawn in correct relation to the diagrams to indicate the thickness of the plate at the enlarged scale produced by the motion mechanism. Flat punches are designated by *F* and shearing punches by *S*. Cards numbered less than 20 were taken on the Bisbee-Endicott punching machine operated under normal conditions. Cards numbered more than 20 were taken on the Olsen testing machine. When punching on the testing machine the stresses were frequently checked by reading the pressures from the scales of the machine.

10 No. 3 is a characteristic card taken while punching a $\frac{1}{4}$-in. mild steel plate with a $\frac{1}{2}$-in. flat punch on the Bisbee-Endicott machine. The inclined line at the left indicates the pressure required to force the point of the punch into the plate, which in this case is about 1000 lb. The maximum stress is obtained at about 6 per cent of the thickness of the plate and is 23,000 lb. This would make the shearing stress about 57,000 lb. per sq. in. The continuance of the pressure to the right of the plate indicates the force necessary to push the bur through the die. Previous to taking card No. 3 the punching machine was operated by hand to test the adjustment of the apparatus and card No. 1 was taken. In this case the pressure under the diaphragm was raised to about 50 lb. before starting to punch, which will account for the abrupt termination of both ends of the card. The maximum stress is the same as that indicated in No. 3, but occurs at about 15 per cent of the thickness of the plate, due to the increase in the time of the operation.

11 The effect on the maximum stress caused by an increase in the time for the passage of the punch through the plate is shown by cards Nos. 9, 38, 39, and 40, in which the range is from about $\frac{1}{4}$ sec. to $8\frac{1}{4}$ min. There is no apparent cause for the rise in the maximum stress of No. 40 and it is possible that the error is in No. 39.

TABLE 1 EFFECT OF TIME ON MAXIMUM STRESS

No.	Time Sec.	Maximum Stress Lb. per sq. in.	Percentage of thickness of plate at which maximum stress occurs
9	$\frac{1}{4}$	31,000	10
38	80	30,000	18
39	310	25,500	18
40	495	26,000	13

12 Card number 7 shows the effect of using a shearing punch under conditions identical with No. 9.

13 The effect on the stress produced by increasing the clearance between the die and punch is shown by the accompanying table and cards Nos. 33 to 43. The tests were made on the Olsen machine, using a die of diameter 0.767 in. and punching a plate 0.315 in. thick.

TABLE 2 EFFECT OF CLEARANCE ON MAXIMUM STRESS

No.	Type of Punch	Dia. of Punch in.	Clearance* in.	Max. Stress Lb. per sq. in.
33	F	0.702	0.065	32,000
34	F	0.738	0.029	33,000
36	F	0.750	0.017	34,500
41	S	0.702	0.065	32,500
42	S	0.738	0.029	34,000
43	S	0.750	0.017	34,000

*Difference in diameters.

14 No. 19 is a card taken while punching a $\frac{1}{2}$-in. plate of mild steel with a $\frac{3}{4}$-in. flat punch on the Bisbee-Endicott machine. This illustrates the effect of a small clearance on the force required to remove the bur, as the difference in diameters of punch and die was but 0.017 in.

GAS POWER SECTION

PRELIMINARY REPORT OF LITERATURE COMMITTEE (III)

ARTICLES IN PERIODICALS

AUTO-MOTOR, TEST OF A FRANKLIN AIR-COOLED, Evans and Lay. *The Automobile, March 31, 1910.* 5 pp., 1 table, 18 curves. *cf.*

Work done in 1907 at Sibley College. Tests in terms of different speeds, different timings of exhaust valve and different materials for air-fins.

BLAST FURNACE GAS POWER PRACTICE, H. J. Freyn. *The Iron Age, June 23, 1910.* 8 pp., 5 figs., 1 table, 6 curves. Also *The Gas Engine, August 1910.*

Operating experiences in South Chicago works of the Illinois Steel Co.

BOX COIL CONNECTION, E. Q. Williams. *Gas Power, September 1910.* 1¾ pp., 1 fig.

Explaining connections which are found in a box coil which are usually covered by wax.

BY-PRODUCT COKE-OVEN, COLLIN REGENERATIVE, C. L. Lomax. *Progressive Age, July 1, 1910.* 1½ pp., 2 figs., 1 heat diagram. *b.*

Interesting record of current progress in German practice.

CALORIFIC POWER OF GAS IN WISCONSIN CITIES, Burgess and Huddle. *Progressive Age, April 1, 1910.* 2½ pp. *Statistical.*

CALORIMETRY, REPORT OF COMMITTEE OF AMERICAN GAS INSTITUTE ON. *Progressive Age, February 1, 1910.* 9½ pp., 1 fig., 11 tables, 5 curves.

Should be read in connection with the earlier reports by the same committee antedating this index. See also editorial on Heat-Units Requirements in same paper, February 15, 1910.

CYLINDER COMPUTATIONS, C. M. Raymond. *Gas Power, September 1910.* 1 p.

Rules and ratios for finding sizes, etc., of cylinders.

ENGINE, 18-B. H.P. PORTABLE SUCTION-GAS. *The Engineer (London), July 15, 1910.* ¾ p., 2 figs., 1 table. *bC.*

Description of a portable suction-gas engine to do same work and fulfil same conditions as the portable steam engine.

DISTRIBUTION PROBLEMS, HIGH-PRESSURE GAS, H. L. Johnson. *Progressive Age, April 1, May 16, June 1, 1910.* 5 pp. *f.*

Paper before Illinois Gas Association with discussion. Concerns itself with practical details of construction.

ENGINE ECONOMY, NOTES ON GAS, P. F. Walker. *Power, June 7, 1910.* 3 pp., 1 table, 5 curves, 20 indicator cards. *c.*

Investigation of influence of richness of mixture upon efficiency at different compressions, made by two students at University of Kansas.

ENGINE INSTALLATION, A NOTABLE GAS. *The Iron Age, March 17, 1910.* 2 pp. *bf.*

Gas-driven blowing engines operating on furnace gas at Carnegie Steel Works, Youngstown, Pa. These 4 gas engines are driven by gas from blast furnaces and deliver blast to the furnaces. Each engine has a rated capacity of 40,000 cu. ft. of air per min. at 18 lb. pressure and 59 r.p.m.

ENGINE, NEW TWO-CYCLE AUTOMOBILE. *The Automobile, March 31, 1910.* ½ p., 1 table, 12 indicator cards.

Brief abstract of tests made at Columbia University.

ENGINE PLANTS, UTILIZING WASTE HEAT FROM GAS, John T. Faig. *The Gas Engine, July 1910;* also *March 1910.* 3 pp., 3 figs., 1 table.

Paper before the National Gas and Gasoline Engine Trades Association Cincinnati, June 15, 1910.

ENGINE PRACTICE, BLAST FURNACE GAS, W. E. Snyder. *The Gas Engine, October 1910.* 5 pp.

Paper on gas engines in Europe, by H. J. Freyn before the Society.

ENGINE, PROGRESS IN THE DIESEL, E. D. Meier. *Power, May 31, 1910.* 2 pp., 1 fig. *ad.*

Abstract of paper before the National Association of Cotton Manufacturers. Discussion of costs of various powers and list of applications of Diesel engine.

ENGINES, AIR SUPPLY TO GAS, W. E. Dalby. *Engineering (London), September 9, 1910.* 1½ pp., 1 fig., 3 tables, 2 curves. *ceB.*

On direct measurement of air supply to a gas engine by means of an orifice and the calibration of the orifice.

ENGINES FOR DRIVING ALTERNATING-CURRENT GENERATORS, GAS, H. G. Reist. *The Gas Engine, August 1910.* 1½ pp.

Explanations of driving alternating-current generators with gas engines.

ENGINES, IGNITION IN GAS AND GASOLINE, Carl Pfanstiehl. *The Gas Engine July 1910.* 7 pp., 1 fig. Also *Gas Power, August 1910.* 3 pp.

Paper before National Gas and Gasoline Engine Trades Association, July 1910. Treats in general sparking devices for gas, oil and gasoline engines.

ENGINES, LARGE GAS, J. D. Lyon. *The Gas Engine, July 1910.* 6 pp., 4 figs.

Paper before the National Gas and Gasoline Engine Trades Association, Cincinnati, June 15, 1910.

ENGINES, MODERN ROLLING-MILL STEAM, E. G. Sehmer and R. Drawe. *Engineering News, June 16, 1910.* 1½ pp. *f.*

Of importance in connection with the introduction of gas power into steel mills. The article was elicited by recent attempts with gas-electric power and auxiliary low-pressure steam turbines, without consideration of recent progress in steam reciprocating engines for this purpose.

ENGINE, SINGLE-STROKE, Consul Benjamin F. Chase, of Leeds. *United States Consular Reports, May 1910.* 1 p.

For automobiles, etc. Two impulses per revolution per cylinder. No mechanical description is given, but the report is on file in Washington, Bureau of Manufactures, with illustrations.

EXPLOSIONS COMMITTEE, THE GASEOUS. *The Engineer (London), September 23, 1910.* 1 p. *b.*

Editorial on work of Gaseous Explosions Committee of British Association.

EXPLOSIONS, GASEOUS. *Engineering (London), September 9, 16, 30, 1910.* 6½ pp., 1 fig., 2 tables, 6 curves. *cA.*

Third report of committee presented to British Association at Sheffield.

EXPLOSIONS IN TUBES, PROPAGATION OF, Chas. E. Monroe. *Proceedings, American Philosophical Society, July 1910.* 4 pp., 1 table. *c.*

Stove-naphtha, vapor and air experiments in connection with explosions in sewers of Penn. R. R. yard at Sheridan, Pa.

FACTORY PLANT, AN INTERESTING GAS POWER, Osborn Monnett. *Power and the Engineer, September 20, 1910.* 4½ pp., 6 figs.

Up-to-date installation.

GENERATORS, MANAGEMENT OF WATER-GAS, John F. Wing. *Progressive Age, May 16, 1910.* 5½ pp., 6 figs., 11 tables.

Paper describing the Everett works, before New England Association of Gas Engineers with discussion.

INTERNAL-COMBUSTION ENGINES FOR MARINE USE, W. R. Cummins. *Transactions, Institute of Marine Engineers, August 1910.* 22 pp. *f.*

Paper is of chief value as an indicator of progress in interest in this topic. The best technical value lies in the discussion, particularly that by O. Sumner, R. N. R., who read a paper on this topic as early as 1901.

INTERNAL-COMBUSTION ENGINES, PROPULSION OF CARGO BOATS BY, R. M. Neilson. *Cassier's Magazine, August 1910.* 8 pp., 3 figs. *a.*

Second half of an article devoted to freight-ship propulsion in general, including discussion of reciprocating turbine, combines and superheating plants.

IRON HORSE, THE, L. W. ELLIS. *Gas Power, August 1910.* 2 pp.

Showing recent developments from early ideas.

MOTOR CONTESTS, WINNIPEG. *The Gas Engine, September 1910.* 6 pp., 3 figs., 2 tables.

Summary of competitive tests of 17 agricultural engines for ploughing, traction, etc.

MOTOR TRIALS, FRENCH KEROSENE. *The Gas Engine, October 1910.* 5 pp., 1 table.

Abstract of competition before a fisherman's aid society among five makes of kerosene-engines.

MOTOR WITH ROTARY INTAKE-VALVES, NEW (DELOCHE) TWO-CYCLE, W. F. Bradley. *The Automobile, July 28, 1910.* 1½ pp., 9 figs. *b.*

OIL-GAS IN CALIFORNIA, DEVELOPMENT OF, E. C. Jones. *Progressive Age, May 2, 1910.* 8½ pp., 8 figs., 21 tables, 1 curve. *bdf statistical.*

Paper before American Gas Institute, Detroit, October 1909.

POUND, STOPPING A TROUBLESOME, A. E. Walker. *Power and the Engineer, October 11, 1910.* ½ p., 1 fig.

Pounding of an unknown origin located by chance.

POWER, POSSIBLE USES OF WASTE GAS, I. V. Robinson. *Power, April 26, 1910.* 1½ pp.

Abstract of paper before West of Scotland Iron and Steel Institute. Chiefly a discussion of costs and values.

POWER, RECENTLY REDUCED VALUE OF WATER. *Engineering News, June 23, 1910.* 1½ pp. *a.*

Editorial reviewing broadly in terms of total relative cost, water, steam and gas power, as affected by recent engineering history.

POWER FROM PEAT, GENERATION OF, T. A. Mighill. *The Gas Engine, October 1910.* 3 pp. Also Presidential Address, American Peat Society, June 28, 1910.

Abstract of paper before the American Peat Society at Ottawa.

PRESSURES, VARYING GAS, W. A. Tookey. *The Gas Engine, August 1910.* 2 pp.

Shows differences in regulation owing to raising or lowering of pressure.

PRODUCER ADAPTED TO HEATING (BY HOT WATER), GAS, F. P. Peterson. *Power, June 14, 1910.* ⅔ p., 1 fig. *f.*

Simple suggestion bearing upon an important problem in applying gas power to mill driving.

PRODUCER FOR BITUMINOUS COAL, DOUBLE-ZONE GAS, E. F. Bulmahn. *Metallurgical and Chemical Engineering, March 1910.* 2½ pp., 3 figs., 1 table, 1 curve. *bcf.*

Tests on various coals and lignites reported in a paper before Engineers Society of Western Pennsylvania.

PRODUCER-GAS POWER PLANTS IN THE UNITED STATES, R. H. Fernald. *Engineering News, May 5, 1910.* 1 p. *bf.*

Paper abstracted from United States Geological Survey, Bulletin No. 416. Data collected from 500 plants in the United States ranging from 15 h.p. to 6000 h.p. per plant.

PULSOMETER (PUMP), GAS. *Progressive Age, January 1, 1910.* ¾ p., 1 table. *bcfA.*

Paper quotes Gas World (London), November 6, 1910. Explosions occur directly against the water.

PUMP, HUMPHREY GAS. *Engineering (London), July 22, 1910.* 3 pp., 5 figs., 1 table, 1 curve. *bcB.*

Description of this interesting pump at the Brussels Exhibition.

PUMP, THE INVENTOR OF THE DIRECT-ACTING EXPLOSION, Wm. H. Smyth. *Engineering News, May 19, 1910.* 1½ pp., 2 figs.

Continuation of the discussion as to the true origin of this device. Mr. Smyth, American, contends with Mr. Humphrey, Englishman.

REMINISCENCES OF EARLY DAYS, SOME, A. E. Walker. *Power and The Engineer, September 26, 1910.* ½p.

Old-style starting devices compared with modern methods.

SMOKE PROBLEM, RELATION OF THE GAS PRODUCER TO THE, R. H. Fernald. *The Gas Engine, August 1910.* 2½ pp.

STEEL WORKS, POWER AVAILABLE IN. *Power, August 2, 1910.* 1 p., 2 figs.

Abstract of paper before Birmingham Association of Mechanical Engineers. Excellently clear diagrams of heat distribution in blast-furnace and coke-oven plants.

SUCTION-GAS PLANTS, DUTCH MARINE, F. Muller van Brakel. *International Marine Engineering, October, November 1909; April 1910.* 6½ pp., 6 figs., 9 tables. *bf.*

Describes practice which has grown up in close contact with the use of gas-power barges of unmechanical skippers without engineers. Also a gas-driven dredge.

SULPHUR COMPOUND IN ILLUMINATING GAS, Chas. R. Rumsburg. *Progressive Age, May 16, 1910.* 7 pp., 6 figs., 1 table.

Paper before American Gas Institute at Detroit, October 1909, with appendix and discussion.

TURBINE, INHERENT DIFFICULTIES OF THE GAS, R. C. H. Heck. *Power, May 3, 1910.* 2¼ pp., 7 figs.

Discussion of the basic thermodynamic considerations involved in cycle of air as compared with that of steam.

TURBINES TO AIR COMPRESSOR, APPLICATION OF LOW-PRESSURE STEAM, J. W. Shepardson, *Engineering Magazine, May 1910.* 14 pp., 2 tables, 9 curves.

Of interest in connection with the problem of gas turbine.

TURBINE, SOME PROBABILITIES OF THE GAS, Sidney A. Rieve. *Power, July 12, 1910.* ⅔ p.

Discussion of fundamental conditions of gas-turbine design.

WARSHIPS, PROPELLING MACHINERY OF, H. J. Oram. *American Society of Naval Engineers, No. 1, 1910.* 5 pp. *f.*

Excellent brief statement by one of those whom marine gas-power propulsion must satisfy giving general accomplishments of steam power which must be excelled.

GAS POWER SECTION

GAS POWER DEVELOPMENT

By James Rowland Bibbins, Mem. Am. Soc. M. E.[1]

Chairman for 1910

In looking over the past year, we may ask ourselves, first, what has been accomplished, second, what forces have retarded development, third, what developments are probable in the near future, and fourth, how can the Section assist in the work? Your retiring Chairman confesses to a desire to grow reminiscent in his declining hours, and would remind you that this privilege comes with the honor of being associated with the work of this active Society in the year 1910, truly a census year. If we are looking for mile stones with which to chronicle our progress we may surely find them today; and a further reason for introspection is afforded by the fact that the Gas Power Section has completed its third year of existence, a period long enough to indicate whether the current of contemporary opinion is with or against us; whether we have achieved a healthy measure of success or have simply been marking time.

DEVELOPMENT

What has been accomplished? As to the Gas Power Section, sufficient, in my opinion, to guarantee the future. At the opening of the present century, many were the prophecies of epochal development in all branches of the technical arts. I believe the decade has fulfilled its promise. First, by way of comparison, we find the steam turbine grown from 300 to 30,000 h.p., with practice both in Europe and America gravitating toward a combination of the two principal types. We find single boiler units increased from 300 to 3000 h.p.; the steam engine, then fully developed, now endowed with a new lease of life through association with its erstwhile rival; and the electric generator literally decimated in bulk but still larger than its turbine.

[1] Address of the retiring Chairman at the Annual Meeting.

In the field of gas power, too, there is measurable progress. In size, engines developed from the single-acting units of 100 h.p. or so, to the double-acting tandem units of 4000 or 5000 h.p. designed for and operating under the same conditions as steam equipment, including the parallel operation of alternating-current generators. We find the steel-casting industry, then comparatively undeveloped, now able to turn out intricate one-piece gas-engine cylinders with jackets attached and crank discs with integral pins of the same material. We find producer units developed from a diminutive 10–50 h.p. up to 1000 h.p. or more and the problem of bituminous fuels well along toward solution, practice tending in the direction of the induction type for both large and small units, with self-contained vaporizer and continuous service. Opinion is somewhat divided as yet on the tar question, but all efforts are directed toward the abolition of this undesirable by-product by gasifying it.

Industrial Applications. But in its varied applications, the direct combustible principle has indeed achieved success. It is obviously no exaggeration to say that the gas engine has made possible the submarine, the aeroplane, the motor boat and the automobile. The aeroplane motor offers an object lesson in the results of high rotative speeds. The 30-h.p. motor of the Wright aeroplane weighs but $6\frac{2}{3}$ lb. per h.p. while the Darracq motor of about the same size, built for Demoiselle, weighs $3\frac{1}{4}$ lb. per h.p. The Gnome engine with radial rotating cylinders weighs still less.

Concerning the much-discussed problem of conservation, I need only refer to the utilization of blast-furnace gas, by-product coke oven gas, by-product oil gas from refineries and various low-grade or by-product fuels unsuited for steaming purposes. A large power plant is now being built to use waste cupola gas which, in heat value, runs about 50 B.t.u. and requires 300 lb. compression. The importance of these developments in solving the smoke problem, the power problem of our specialized manufactories and in deferring that national crisis, the extinction of fuel supply, cannot be overestimated.

On the one hand, the gas driven pump by reason of its high efficiency has found adoption in water works, sewage disposal, hydraulic excavation and long-distance gas transmission. On the other hand, by reason of the absence of stand-by losses it is equally desirable in emergency service, such as fire protection, hydro-electric auxiliary plants and canal lock operation. The coincident and related development of producers has brought about a revolution in such operations as hardening, tempering, melting, soldering, baking

and cloth singeing and especially the displacing of the supposedly indispensable Bessemer converter by the open-hearth furnace in single units of 400 tons or over.

Gas Engine. The development of the heavy-duty double-acting gas engine has been accompanied by certain interesting features, which while not universal, yet find quite wide acceptance in American designs. Foreign center-crank designs have been generally departed from in the use of the side-crank self-adjustable bearing construction. Experience has been gained with various cylinder materials, all steel or iron, steel walls only, cast-iron liners, both iron and steel pistons and with steel on steel. The trouble predicted with the latter does not seem to have materialized, as the gaging of piston clearances at any time is a simple matter. Krupp builds thin walls with longitudinal reinforcing tension rods while other foreign builders design cast-iron walls as thick as 3 in. Dry metallic packing has been substituted for the elaborately water-cooled style. Fads in valve gear are rapidly disappearing and the mechanism has been simplified by driving both inlet and exhaust valves from a single cam. In early practice the regulator was driven from any convenient point along the camshaft, but is now driven directly from, or at a point close to the main shaft so as to avoid cyclic torsional effects in the camshaft. Direct governing has largely been replaced by the relay type using drop cut-off or positive oil pressure to move the valves. This has permitted the use of a very small regulator, usually on the German straight-line principle, as represented by the Jahns and Hartung design, the weights moving directly against spring pressure. Mixing is now done only at the inlet valves, thus minimizing the result of a back-fire. By the symmetrical distribution of gas and air with reference to the four inlets, non-uniform mixing due to unequal fluid inertia effects have largely been overcome. The electro-magnetic igniter has found much favor by reason of its simplicity, and has made possible ignition at several points in the combustion chamber, bringing more rapid as well as surer combustion with lean gases. A series system of circulation has reduced the water consumption and also the troubles from sweating of cold rods with high sulphur gas. The foreign practice of cambering rods is entirely disregarded here, for with light, one-piece pistons, the rod flexure is not greater than considered desirable to keep the sectional packing free. And, finally, centralized continuous return lubricating systems are the rule for engine oil, with timed force feed for cylinder oil, this latter replacing all attempts

at graphite lubrication or indiscriminate injection of oil during combustion.

The special adaptation to direct connection with reciprocating compressors has brought about the variable-speed long-stroke gas engine (of two diameters or more). These are operated in the natural gas districts of the Central and Western states. One company alone has 24 of these units in service of about 1300 h.p. each. An interesting feature brought out by some recent tests by the author is that for the same power output the gas and heat consumption is not widely different at full or reduced speeds and about the same as an electric engine of normal proportions.

A moderate-sized double-acting engine has also come into use. It has a stroke of about 2 ft. and its high rotative speed, 200 r.p.m., is of great advantage in direct-connected electric drive.

The gas-electric motor car is another interesting development which has been under investigation for several years by railroads for service on extensions or suburban branches where regular steam equipment has not been justified. These cars are self-propelled by a compact 8-cylinder high-speed generating set located in the cab, and standard electric-motor control. Sixty-seat coaches ordinarily make an average schedule speed of 25 mi. per hr. including stops. Demonstration runs have resulted in a gasolene consumption of 0.36 to 0.48 gal. per car-mile. A single truck car of this type has been on trial for cross-town service on some of the lines in New York City not yet electrified.

So much for progress and accomplishment. The evidence exists throughout the land from the thousands of small engines upon the hillsides of the Pennsylvania oil fields to the great installations at Gary, Buffalo and Pittsburgh, in the Mexican highlands with a central station burning mesquite, in Texas with its lignite, in Canada with its peat, in the Nevada ranges with a mining plant of Diesel oil engines, in Nova Scotia and Buenos Ayres which are running railroad shops, in Ohio with its boosting of gas to Cleveland, in the watering of the Imperial Valley reclamation in Arizona, in Philadelphia and Coney Island with their high-pressure fire protection systems, and in Pittsburgh with its operation of the locks of the Ohio canalization project. This is admittedly a good record but we should never be guilty of that smug satisfaction that blinds us to minor shortcomings. So let us glance at some aspects and causes of retarded development.

RETARDATION

A very serious handicap in industrial work is the present inability of the gas power system to accomplish factory heating in lieu of exhaust steam. This is particularly serious in the Northern states and in Canada. Unfortunately the high efficiency of the gas engine is lost in comparison with the "steam eater" desired in a heating plant. Some progress is being made with the manufacture of exhaust heaters, but the available 5000 or 6000 B.t.u. per b.h.p. is not sufficient for heating a large factory. Some system of auxiliary gas-burning heater must be worked out with automatic temperature control to compensate for the variation in load. An attempt at conserving this sixty-odd per cent waste heat, now rejected, should be made so as to return the major part of it to the heat cycle. The gas engine is roundly scored for not having overload capacity for fluctuating peak loads. Now with an efficient regenerating heater operating in connection with a low-pressure steam-turbine auxiliary, it is possible largely to increase the output, or vice versa, the economy. I am glad to report that one of our manufacturers is working along this line on a projected plant.

We must have more convenient and practical methods of measuring power gas, both with respect to volume and especially to heating value. No sensible individual would attempt to operate a steam plant without a pressure gage, even neglecting the personal risk, but with gas we are working continuously in the dark and with engines equally sensitive to reduced potential as with steam. Some large plants have, of course, adopted the Venturi meter, but even this simple apparatus is sensitive to deposits in the throat. A continuous recording calorimeter is a great necessity and progress is being made in this direction.

There is a disposition to discount the demand for large units, both engines and producers. With turbine units increasing by leaps and bounds, the gas power industry must respond in kind if not in equal measure or remain an auxiliary for special conditions. The 44-in. by 60-in. cylinder is now in evidence. Let us have higher rotative and piston speeds with relatively shorter stroke and larger diameters if possible. The Lentz steam engine is a remarkable example in this respect. It is only to be expected that the production of special high-tensile steels and further perfection of foundry practice will make this possible. This improvement in engine construction will remove one of the causes of complaint in the past on

large engines, the failure of cylinders and pistons, due for the most part to shrinkage or temperature strains.

Nor can it be believed that the producer fuel bed has reached the limit of its diameter, and with a rate of gasification only 15 lb. per sq. ft. per hr. At this rate an 8-ft. producer would yield only 750 b.h.p. Marine and locomotive practice with induced draft succeeds with many times this rate. A full-grown power plant of today requires units of 3000 to 5000-kw. capacity with at least 2000-h.p. producers.

Finally, there is a lack of education not only on the part of operator but of salesman and manufacturer as well. The last-named is often the least wide awake, the first the most receptive of intelligent guidance. The great mistake is made in semi-education; first, an incomplete understanding of the conditions, second, a make-fit equipment, third, a jealous guarding of essential knowledge of defects. The result is loss of confidence, dissatisfaction, failure. When will we learn that to take the operator into our full confidence secures his allegiance for all time?

THE FUTURE

Marine Propulsion. This most important development looms big on the horizon. Much has been written of the producer gas system, but it must be confessed that the oil-burning engine is more attractive from the standpoint of convenience and compactness. The advantage of storing oil in the ship's double bottoms is great from a standpoint of cargo capacity. European countries have been active in this development: Russia with its tank ships, France with its submarines and the coast countries with their fishing fleets. Successful producer-gas equipments are to be found on some of the inland waterways of Europe, where coal is the cheaper fuel, and a boat is being equipped here for service in New York harbor.

Recently the announcement has come of the adoption of oil engines for the 8000-ton, 12.5-knot freight boats now being built by the Hamburg-American Line. These will be equipped with two 1500-h.p. Diesel engines built by the Augsburg and Nurnberg works, and if the experiment is successful, passenger vessels will be constructed. One American builder, at least, has taken up the Diesel engine for marine work.

Power from Crude Oil. The oil-engine development seems to have made great headway abroad since the expiration of the basic Diesel patents. Three of the principal companies have built 500,000-h.p.

with four and six cylinder units up to 2000-h.p. capacity per cylinder. The Diesel firm is building on this principle as small as 5–30 h.p. The smaller engines are mostly four cycle while above 1000 h.p. the two-stroke cycle prevails, which in an oil engine, works out much more simply than in a gas engine which requires a separate pump for both gas and air. Maximum compression is somewhat over 500 lb., with air injection at 600–850 lb. In most cases the compressors are built into the main unit and geared, not as a separate auxiliary. Some of the builders are reported to be developing double-acting designs for engines of high power.

In London, one of the electric supply companies has installed Diesel engines to supplement the transforming equipment of its sub-stations, using oil distillate at a cost per kw-hr. lower than that from the main stations. A somewhat similar type of plant in one of our Eastern cities is used to boost the potential of low points in a direct-current distribution system. The generator, however, is under-compounded so as to limit the output and thus equalize with other parts of the network. Obviously the oil engine is an ideal prime mover for this work.

In the various experiments with oil-gas producers, the small progress has been discouraging. Two systems have been used, the retort and the partial combustion. In the former, difficulties with carbon deposition in the retorts are encountered; in the latter, excessive production of lamp black. Both are hopelessly low in efficiency as compared with oil-burning steam plants. A large oil-gas plant, in California, operating gas engines as water power auxiliaries, endeavors to apply to power purposes mixed gas, consisting of part retort and part carburetted water gas, utilizing the carbon deposits of the former as bricquettes in the latter process. In this mixed gas, the hydrogen content is kept down to about 30 per cent, but in the oil-gas it is very much higher, 40–60 per cent. For straight power purposes the combustion producer seems more promising, both in simplicity and efficiency. The Imperial Valley project is being served by a small lift station of this type at Yuma, Arizona.

Power in the West. Closely related, is the development of the western power fields, both for irrigation and for mining operations. The Easterner cannot realize to what extent irrigation has taken hold of the West and what a field there is for power pumping if we can only develop it. Utah, Arizona, Texas and the Great Plains embrace broad areas underlaid by basins of hard pan yielding ground waters, which vary in depth from a few feet in favored areas to 50 or 75 ft. in

others. At present, electric power pumping is predominant. John C. Hays,[1] in discussing a California installation, an area of 1050 sq. mi., 86 per cent of which is electrically irrigated, declares there is no reason why this field should not be open to gas-power pumping. One installation is already projected with gas-driven generators, but why not direct pumping? No one familiar with the ever-present gas pumpers of the oil fields will fail to see the parallel. But we must have a low-priced engine, simple, "fool-proof", and preferably of a high-speed multi-cylinder type adapted to direct connection to centrifugal pumps. Present types of high-speed engines are not readily adaptable to rotary pumps because of the disparity between impeller proportions and engine speed, although a few sizes can be found suited to low-head work. The new Humphrey gas pump is evidently suited to the service, in fact, it is already operating in India in irrigation enterprises. Recently a unit as large as 25,000,000 gal. was contracted for. This pump utilizes the water column itself as a piston and is approximately "fool-proof".

A crude oil engine is obviously a necessity in the far West. East of the Rockies, a lignite suction producer in small sizes would find application, but in California oil predominates. In 1908 the production was 48,300,000 bbl. at an average price of $0.54 per bbl. The majority of this was asphaltum base oil, 12 to 17 deg. Baumé being used for oil-gas generation.

In the mining districts, we find wood, charcoal and black lignite used for steaming purposes, even where water is scarce and impure. One plant, however, accepted the situation and installed Diesel engines with a continuous closed fan-cooling system for jacket water.

The development of lignite deposits in the middle West is encouraging. In 1907, the output west of the Mississippi was 5,000,000 tons, of which Colorado produced one-third, with Wyoming and Texas next in rank, with an average price of $1.55 per ton as compared with $1.12 for all bituminous coal mined in this country. This price does not of course apply to the more inaccessible regions where fuel costs $4 to $8 per ton. Here in the West is indeed an opportunity.

Canada. We have looked to Canada for important developments in the use of peat, but private experiments have failed so signally that the Government has started a peat manufacturing and power plant to demonstrate the process on a commercial scale and reëstablish confidence in this industry. Director Haanel of the Bureau of

[1] Proceedings Am. Inst. E.E., May 1910. The Mt. Whitney Power Co.

Mines thus summarizes his investigations: Artificial drying processes have failed commercially and a machine process must be substituted for manual labor. The department is therefore proceeding along European lines of established success. He states that Russia alone produced 4,000,000 tons of peat fuel in one year, 1900. Peat containing not over 25 to 30 per cent water has been found an ideal fuel for gas producer work requiring no further vapor and is quite free from high temperature and clinker. The long series of fuel tests at Montreal have served to confirm the results of our Government tests on lignites in demonstrating the great possibilities of these lignite deposits, especially in the Canadian North West.

Self-Starting Engine. No real progress is apparent in the self-starting gas engine. Some automobiles are equipped with small compressed-air motors, but at considerable expense. No simple combustion method has yet appeared. The opportunity is clear. On very large units, one builder employs for starting an explosive mixture compressed to about 80 lb. and stored in the same manner as the usual compressed air. Some trouble has been experienced in guarding against back-fires into the storage tank.

Double-Deck Stations. In large cities where land is dear a new style of power plant would seem to have some possibilities. The double-deck type with the producer plant above has some advantages over the familiar double-deck turbine plant in that the building steel work would be designed for a dead load, concentrated along the supporting walls where the producers would naturally be located. I am not sure of the comparative costs, but the economy in space in a large plant works out relatively low.

UNDEVELOPED FIELDS

Engineering Economies. Returning now to a consideration of some of the broader aspects of this subject, it seems to me that there are some fruitful fields still undeveloped. Engineering today has become not entirely a technical, but an economic science as well. We must not only ask the question, will it work, but first and foremost, will it pay the proper return on the investment. Consider for example the total cost of power production. How much earnest effort has been thrown away in fruitless discussions of mere operating costs, technical finesse, when the language of fixed charges, depreciation, obsolescence, supercession and business risk had not been fully learned. This phase of gas power development has been serious in

the past and is undoubtedly responsible for many of the failures on record. Such problems continually arise in the course of comparative studies of gas producer and turbine plants with various load factors and prices of coal. The success of the by-product coke-oven industry in realizing profits from its by-products, rests solely upon the economics of the case, and abruptly raises the question, which is the major product, gas or coke. The analysis of the cost of production is far more important than that of microscopical improvement in efficiency.

Technical Consular Attaché. No one can deny the great value of detailed knowledge of the development of the arts in foreign countries. Private individuals or corporations constantly invest large sums in securing such information for their purposes. Now in view of the extended activity of our Government along scientific and commercial lines as evidenced by the Geological Survey, the Bureau of Mines, the Bureau of Standards, and the Smithsonian Institution, does it seem unreasonable to broaden the usefulness of our consular service by the establishment of a new function, a technical investigating staff whose duty it would be to keep constantly before American engineers the more important achievements of foreign contemporaries? The excellent report on Peat and Lignite by the Canadian Bureau of Mines is a case in point. The fact is that progress today is so rapid that no individual can hope, unaided, to keep abreast without expending more time than is available in general investigation that should properly be detailed to special talent. And it seems to me that the national engineering societies should be the leaders in fostering this activity.

Coöperative Research. The movement toward the coöperation of the engineering fraternities with the educational institutions should be encouraged, by the more widespread establishment of technical apprenticeships in our shops and offices. It is no exaggeration to assert that today the technical graduate furnishes the new blood of industrial enterprise. His training and his ideals form the groundwork of a steadily improving standard in commercial life. By the same token the colleges have a right to expect coöperation. Their costly laboratories are at our disposal for the asking. We spend millions in commercial experiments that can at least yield only approximations. Many of these investigations should be transferred to the laboratory.

There is now before the technical institutions of the country a comprehensive list of subjects needing scientific investigation, many

of them of the utmost importance. Could we persuade the manufacturers of the country to endow graduate fellowships in their chosen fields with ample funds for defraying the material costs of such investigations, the return on their investment, I believe, would be well above the market rate of interest. A few progressive concerns have taken this step, but they may be regarded only as a precedent. One technical institution has itself provided an endowment. Interest the student in your business by affording him some incentive and he will become a loyal apprentice, an effective salesman and a competent executive. I beg to suggest that this Section take more definite action through the Society, along these coöperative lines. As subjects, I need only mention the following as typical.

a Maximum efficient rate of combustion in producers as effected by width and depth of fuel bed, rate of blast, moisture content and character of fuel.

b Study of chemical reaction in the fuel bed to determine the conditions for suppressing the formation of tar or lamp black and securing maximum percentage of combustibles in gas together with high overall efficiency.

c Study of the relative jacket absorption with varying time contact due to different combustion chamber and cylinder proportions, and piston speeds.

d Effect of auxiliary precompression of charge on efficiency and power of gas engines with reference to securing unlimited overload capacity.

e Determining of most suitable form of gas engine indicators to standardize accurate methods of working.

f Research work on maximum heat values of combustible mixtures standardizing formulae for the standard reference cycle.

It seems to me that the progressive spirit of the true investigator is well expressed in a little quatrain of Rudyard Kipling, Initiative and Leadership. It runs thus:

> "They asked him how he did it and he gave 'em the Scripture Text,
> You keep your light so shining a little in front of the next.
> They copied all they could follow but they could not copy his mind,
> And he left them sweating and stealing a year and a half behind."

The answer is, initiative pays. Anybody can follow.

Work of the Section. Finally, as to the work of the Gas Power Section, the interest manifested in the last few meetings indicates that it has been productive of results. Out of 180 papers presented to the Society within the last five years, 24 have been devoted to gas

power or related subjects; two committees have presented comprehensive reports, and a third its detail work from time to time. Although none of the committees now at work have reported conclusively, their preliminary reports have furnished an ample basis for further action. Possibly the most pressing need is the standardization of tests and efficiency determinations. These matters were brought to the attention of the Society in concrete form by the Standardization Committee of this Section and are now in the hands of the Power Test Committee of the Society.

The greatest value, therefore, of the Section rests in the contributions to the art in the papers or reports presented. We should not glory in mere numbers, but on the other hand, excessive concentration in the choice of subjects does not effectively reach the full membership. We may well accept the two contributions on blast furnace practice as an earnest of our desire for contributions of the highest possible standard. I have heard Lord Bacon quoted on this theme: "I hold every man a debtor to his profession from the which, as men, of course, do seek countenance and profit, so ought they of duty endeavor to be a help and ornament thereto." This seems sound doctrine and in the belief that it will not fall on arid ground, I look for the continued growth of this membership with the very keenest interest.

GENERAL NOTES

AMERICAN SOCIETY OF CIVIL ENGINEERS

At the December 7 meeting of the American Society of Civil Engineers, papers were presented on Bond-Friction Resistance in Reinforced Concrete, by William Fry Scott, and on Hydrography as an Aid to the Successful Operation of an Irrigation System, by J. C. Stevens. On December 21, the papers discussed were Notes on the Bar Harbors at the Entrance to Coos Bay, and Umpqua and Suislaw Rivers, Oregon, by Morton L. Tower, and Timber Preservation, its Development and Present Scope, by Walter Buehler. On January 4, Henry Earle Riggs will present his paper on The Valuation of Public Service Corporation Property.

The Society will hold its annual business meeting on January 18 and 19 at its headquarters on 57th Street, which will be the occasion of the annual reports of the election of officers for the ensuing year, amendments to the Constitution, and other matters of a similar nature. On January 20 and 21 special meetings will be held for topical discussion on the general subject of Road Construction and Maintenance, with particular attention to the relative value of the three methods of carrying on this work, the systems of maintenance, and dust palliatives, surface treatment, and penetration and mixing methods. All engineers interested in road building are invited to be present.

For the trip to be made to the Isthmus of Panama in March, the society has chartered two steamers from the United Fruit Company, one of which will leave New York on March 2, returning on March 24, and the other leaving New Orleans on March 4 and returning to that city on March 21. Both will go directly to Colon and after a brief stop proceed on the cruise, stopping again on the return route. Reservations must be individually secured from the company before January 15.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

At the monthly meeting of the American Institute of Electrical Engineers, to be held in the auditorium of the Engineering Societies Building on January 13, the general subject will be Corona, on which two papers will be presented by Prof. Harris J. Ryan, one entitled Atmosphere in the Open and Dry Transformer Oil as High Voltage Insulators, and the other, A Power Diagram Indicator for Use in High Tension Circuits.

AMERICAN INSTITUTE OF MINING ENGINEERS

The annual business meeting of the American Institute of Mining Engineers will be held on February 21, 1910. At this meeting there will be the annual election of directors, and the transaction of other business, including a report of the financial condition of the Institute. Following this meeting there will

be a session for the presentation and discussion of technical papers, which will probably be held in some city in the East.

CEMENT EXHIBITION AND CONVENTIONS

Two conventions, one the seventh annual convention of the National Association of Cement Users, held at Madison Square Garden, and the other the annual meeting of the Association of American Portland Cement Manufactures, held at the Hotel Astor, as well as the first annual New York Cement Show, which opened in Madison Square Garden on the evening of December 14, brought many men representing cement interests to New York during the week of December 12.

In the exhibition, which was opened by Mayor Gaynor of New York on Wednesday evening, 250 firms participated, covering every available square foot of space, in the exhibition hall. The cement house designed by Thomas A. Edison and also the house which won first prize at the recent convention for the prevention of tuberculosis were among the prominent displays. Many foreign exhibits in cement progress were also included, giving the whole an international aspect.

Among the prominent speakers at the two conventions were Calvin Tomkins, commissioner of docks and ferries; Col. J. Hollis Wells; Dr. Walter Page, director of the Agricultural Department, Washington; Charles Wisch, chief municipal architect, Cologne, Germany; E. P. Goodrich; John Purroy Mitchell, president of the Board of Alderman, New York; John Carrere; Charles Battell Loomis, Robert W. deForest, John R. Morron, Benjamin D. Traitel, and Robert W. Lesley. The Civil Engineers' Societies of France and Germany and the Cement Association of Great Britain were officially represented at the meetings.

INTERNATIONAL EXHIBITION OF MECHANICAL EQUIPMENT

An international exhibition of mechanical equipment of all sorts and of the novelties and patents of the iron and engineering industry is to be held at Industry Palace, Budapest, Hungary, in May and June, 1911, under the direction of the National Association of Hungarian Ironmongers and the Royal Board of Trade of Hungary. The exhibition has for its object the dissemination among the engineers and manufacturers of Hungary information regarding machines for industrial and agricultural purposes, steam and gasoline engines, refrigerating plants, mining machinery, etc., and patented equipment for various other purposes. American manufacturers are invited to display their products.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The third annual meeting of the American Institute of Chemical Engineers opened on Wednesday, December 7, in the Hotel Astor, New York, with a business meeting and papers on the Development of the Chemist as an Engineer, by Dr. Fred. W. Atkinson, of Brooklyn; The Training of Chemical Engineers which Meets the Requirements of Manufacturers, by Prof. M. C. Whitaker, New York; The Fitzgibbons Boiler, by Jerome Alexander. In the afternoon an excursion was made to the Marx and Rawolle Glycerine Refinery in Brooklyn. The evening

session held at Columbia University included an address of welcome by Prof. M. T. Bogert, the address of the retiring president, Chas. F. McKenna, and a paper on the Manufacture of Hydrated Lime, by Richard K. Meade. Thursday was devoted to excursions to the chamber acid plant of the Standard Oil Company at Bayonne, N. J., and to the Borough of Richmond Garbage Destructor. A dinner at the Hotel Astor occupied the evening. The professional session of Friday morning was again held at the Astor and included papers on the Manufacture of Lignite Briquettes, by Henry W. Renaud; Bleaching Oils with Fullers Earth, by David Wesson; Action of Fruit Juices on Metallic Containers, by Edward Gudeman; and Vacuum Distilling Apparatus, by Philip B. Sadtler. Excursions were made in the afternoon to the candle house of the Pratt Works, Standard Oil Company, and also to the grease works of the same company, both located at Blissville, L. I. The evening meeting was a joint session with the New York Session of the American Chemical Society and was held at the Chemist's Club. Papers were read on the Principles of Sewage Disposal, by George C. Whipple; Sewage Disposal in Europe, by Rudolph Hering, Mem. Am.Soc.M.E.; Sewage Disposal in New York and Vicinity, by Dr. Geo. A. Soper; Sanitary Conditions in their Relation to Water Supplies in the Vicinity of New York, by Nicholas S. Hill, Jr.; and the Unsolved Problems of Sewage Disposal, by Prof. Chas. E. A. Winslow. Saturday was devoted to the inspection of the chemical museum and laboratories of Columbia University and of the College of the City of New York.

NEW JERSEY SANITARY ASSOCIATION

The program of annual meeting of the New Jersey Sanitary Association, held at Lakewood, N. J., December 2 and 3, 1910, included papers on Two Years Experience in Dust Suppression on Roads, by James Owen, Mem.Am. Soc.M.E.; Disposal of Trade Wastes, George A. Johnson; The Possible Deleterious Effects of Illuminating Gas upon the Human Economy, by C. E. Forstall and the presidential address on Latest Phases of Sewage Purification, by Rudolph Hering, Mem.Am.Soc.M.E.

NATIONAL COMMERCIAL GAS ASSOCIATION

The annual convention and exhibition of the National Commercial Gas Association, held in Boston, December 5–13 included papers on Manufacturers' Paper, Wm. T. Barbour; Industrial Fuel, A. V. Wainwright; Illumination, Norman Macbeth; Service, C. W. Hare; Rates, Henry L. Doherty, Mem.Am. Soc.M.E.; Compensation of Representatives, J. D. Shattuck; A Traveling Salesman's Views of the Commercial Department, H. L. Schutt; Lighting and Fuel Maintenance, F. J. Rutledge; Relations with Customers, V. A. Henderson. A banquet at the Hotel Somerset with trips to historical points of interest were arranged by the committee in charge.

MODERN SCIENCE CLUB

At the meeting of the Modern Science Club at its club house in Brooklyn, N. Y., on December 6, L. G. Benton of the Norben Oil Company gave an address on the Manufacture and Use of Lubricating Oils, and on December 13, Fred. R. Low, Mem.Am.Soc.M.E., Editor of Power and the Engineer, spoke upon Entropy.

PERSONALS

Frederic W. Bailey has become identified with the construction engineering department of the General Electric Co., Schenectady, N. Y. He was until recently associated with the Solvay Process Co., Syracuse, N. Y., in the capacity of draftsman.

C. W. E. Clark has resigned the position of steam engineer with the N. Y. C. & H. R. R. R. Co., to accept an appointment with the Stone & Webster Engineering Corporation of Boston.

Charles H. Delany has entered the employ of the Pacific Gas & Electric Co., San Francisco, Cal., in the department of operation and maintenance. He was formerly associated with the Babcock & Wilcox Co., Bayonne, N. J.

Charles H. Doebler has become master mechanic of the C. & O. Ry. Co. of Indiana, Peru, Ind. Until recently Mr. Doebler was general manager of the Lima Brake Shoe Co., Lima, O.

Wm. F. Gillies has become associated with the Ingersoll-Rand Co. of Texas, El Paso, Texas, in the capacity of secretary.

J. Howard Hayes has become connected with the turbine department of the Platt Iron Works Co., Dayton, O. He was formerly partner of the F. H. Hayes Machinery Co., Boston, Mass.

Fred. M. Hitchcock, formerly with the Ingersoll-Rand Co., New York, has been appointed executive engineer of the Dexter Folder Co., Pearl River, N. Y.

A. W. Patterson, recently associated with the Invincible Electric Renovator Sales Co., Boston, Mass., as manager, has become district manager of the Yale & Towne Manufacturing Co., New York.

L. R. Valentine has been transferred from the Security Cement & Lime Co., Security, Md. to the Charles Warner Co., Devault, Pa.

J. G. Vincent, recently in the employ of the Burroughs Adding Machine Co., Detroit, Mich., has accepted a position with the Hudson Motor Car Co. of the same city.

D. J. Whittemore has resigned as chief engineer of the Chicago, Milwaukee & St. Paul Ry. Co. and of the Chicago, Milwaukee & Puget Sound Ry. Co., to become consulting engineer of the former company, with office in Milwaukee, Wis.

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society, included in the Engineering Library. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary, Am. Soc. M. E.

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NEW YORK CITY, BOROUGH OF RICHMOND. Annual Report 1902–1906. *New Brighton, 1902–06.* Gift of President of the Borough of Richmond.

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EARLE C. BACON, *New York City.* Hoisting engines and mining machinery, 134 pp.

BALL ENGINE CO., *Erie, Pa.* Steam engines, side crank type, 40 pp.

BERLINER MASCHINENBAU GESELLSCHAFT, *Berlin, Germany.* 4-4-0 superheated steam passenger locomotive, 12 pp.; Notes on superheated steam locomotives, 9 pp.; Ten-coupled, ten-wheeled superheated steam locomotives, 9 pp.; Six-coupled, eight-wheeled superheating express engine, 37 pp.; History of the Berliner Maschinenbau Gesellschaft, 46 pp.; Various types of locomotives, 63 pp. 4-6-0. four-cylinder superheated steam express locomotive, 14 pp.; Four-cylinder compound express locomotive of the Danish railways, 24 pp.

BRISTOL CO., *Waterbury, Conn.* Bull. no. 140. Recording gages for all ranges of pressures and vacuum, 47 pp.

BUSH STEAM GENERATOR CO., *New York City.* Steam generators, 5 pp.

GERARD DEVELOPMENT CO., *New York City.* Herrick balanced rotary engine report, 4 pp.

LEEDS & NORTHRUP CO., *Philadelphia, Pa.* New shop and laboratory, 12 pp.

LINK BELT CO., *New York City.* Conveying machinery for sugar estates and refineries, 52 pp.; Conveying machinery for coal mines, 42 pp.; Peck carrier for coal, coke, ashes, cement, etc., 96 pp.; Conveyors for freight and packages, 64 pp.

OHIO BRASS CO., *Mansfield, O.* Bulletin, Oct.–Nov., 1910, 22 pp.

UNDERFEED STOKER CO. OF AMERICA *Chicago, Ill.* Publicity Magazine, December 1910, 16 pp.

WHITNEY MFG. CO., *Hartford, Conn.* Roller chains and block chains, 38 pp.; Dimensions of Whitney chains, 40 pp.; Machine keys and key seat cutters, 24 pp.; Milling machine appliances, 16 pp.

EMPLOYMENT BULLETIN

The Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 12th of the month. The list of men available is made up of members of the Society and these are on file, with the names of other good men not members of the Society, who are capable of filling responsible positions. Information will be sent upon application.

MEN AVAILABLE

154 Junior, graduate M.E., practical experience as inspector materials of construction; experimental steam engineer, superintendent of power plant. Now engaged as assistant master mechanic of large manufacturing concern. Desires position as assistant superintendent or manager of industrial plant or engineer-salesman of power plant equipment.

155 Graduate Columbia University, four years experience design, construction and testing of gasolene engines; desires permanent executive position with progressive concern in engineering or shop department, Eastern states preferred. Familiar with recent shop practice; successfully handled American and European skilled labor.

156 Member desires other engagement; sixteen years experience in modern blast steelworks and rolling mill machinery, gas engines, gas producers etc.; chief mechanical engineer, best of references.

157 Position desired as inspector with consulting engineer or firm contracting engineers. Five years experience as an erecting foreman. Speciality, railway engineering; age twenty-six. College training.

158 Young engineer, graduate Stevens Institute Technology; executive ability, experience in industrial engineering and factory management; specialized in power plant equipment, condensers and cooling towers, desires position leading to administrative responsibility.

159 Position desired as shop engineer, devising ways and means of doing work; experience as tool room foreman and designer of machines for various parts of product semi and full automatic.

160 Cornell University graduate in mechanical engineering, experience in the electrical field, engineering sales and executive branches of the profession specializing in elevating and conveying problems. Prefers position as engineer or manager with concern engaged in general engineering and contracting work.

COMING MEETINGS

JANUARY—FEBRUARY

Advance notices of annual and semi-annual meetings of engineering societies are regularly published under this heading and secretaries or members of societies whose meetings are of interest to engineers are invited to send such notices for publication. They should be in the editor's hands by the 15th of the month preceding the meeting. When the titles of papers read at monthly meetings are furnished they will also be published.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

December 27–January 3, Minneapolis and St. Paul, Minn. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

THE AMERICAN INSTITUTE OF ARCHITECTS

January 17–19, annual convention, San Francisco, Cal. Papers: The Development of Architecture on the Pacific Coast and the Rehabilitation of the City of San Francisco. The Aesthetic Problems of and what the Coast has Accomplished in City Planning, The Salient Points of the Architecture of the Northern Pacific Coast, by Chas. H. Bebb; History and Present Status of the California Missions, by A. B. Benton. Secy., Glenn Brown, The Octagon, Washington, D. C.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

January 13, 29 W. 39th St., New York. Secy., R. W. Pope.

AMERICAN INSTITUTE OF MINING ENGINEERS

February 21, annual business meeting, 29 W. 39th St., New York. Secy., Dr. Joseph Struthers.

AMERICAN SOCIETY OF CIVIL ENGINEERS

January 4, bi-monthly meeting, 220 W. 57th St., New York. Paper: The Valuation of Public Service Corporation Property, Henry Earle Riggs. January 18, 19, annual business meeting; January 20, 21, meetings for topical discussion. Subject; Road Construction and Maintenance. Secy., C. W. Hunt.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

January 24–26, annual meeting, 29 W. 39th St., New York. Secy., W. M. Mackay, Box 1818.

ASSOCIATION OF ONTARIO LAND SURVEYORS

February 28, annual meeting, Parliament Bldgs., Toronto, Can. Secy., Killaly Gamble, 704 Temple Bldg.

AUTOMOBILE EXPOSITION

December 31–January 7, Grand Central Palace, New York. Secy., B. Briscoe, 7 E. 42d St.

BOSTON SOCIETY OF ARCHITECTS

January 3, annual meeting, Parker House, Boston, Mass. Secy., Edwin J. Lewis, Jr., 9 Park St.

CIVIL ENGINEERS SOCIETY OF ST. PAUL

January 9, annual meeting, Old State Capitol Bldg., St. Paul, Minn. Secy., F. D. Jurgensen, 116 Winter St.

ELECTRICAL CONTRACTORS ASSOCIATION OF NEW YORK STATE

January 10, ex-semi annual meeting, Albany, N. Y. Secy., Geo. W. Russell Jr., 25 W. 42d St., New York.

ENGINEERS SOCIETY OF PENNSYLVANIA

January 16, annual meeting, Harrisburg, Pa. Secy., Edw. R. Dasher, Gilbert Bldg.

ENGINEERS SOCIETY OF WESTERN PENNSYLVANIA

January 17, annual meeting, Oliver Bldg., Pittsburg, Pa. Secy., E. K. Hiles, 803 Fulton Bldg.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS

January 25–27, annual meeting, East St. Louis, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Blk., Chicago, Ill.

INDIANA ENGINEERING SOCIETY

January 12–14, annual meeting, Indianapolis, Ind. Secy., Chas. Brossman.

THE NATIONAL CIVIC FEDERATION

January 12–14, annual meeting, Hotel Astor, New York. Chairman Executive Council, Ralph M. Easley, 1 Madison Ave.

NEBRASKA CEMENT USERS ASSOCIATION

February 1–3, annual convention, Omaha. Secy., Peter Palmer, Oakland.

SOCIETY OF AUTOMOBILE ENGINEERS

January 11, 12, annual meeting, New York. Papers: Automobile Springs E. K. Rowland; Highways for Motor Traffic, Logan W. Page; Motor Tests, R. C. Carpenter, Mem.Am.Soc.M.E.; Impurities in Commercial Gasolene, Frank H. Floyd; Gears with Rolled Teeth, A. N. Anderson. General Manager, Coker F. Clarkson.

WISCONSIN ELECTRICAL ASSOCIATION

January, annual meeting, Milwaukee, Wis. Secy., J. S. Allen, Lake Geneva, Wis.

MEETINGS IN THE ENGINEERING SOCIETIES BUILDING

Date	Society	Secretary	Time
January			
4	Wireless Institute	S. L. Williams	7.30 p.m.
5	Blue Room Engineering Society	W. D. Sprague	8.15 p.m.
10	American Society Mechanical Engineers	C. W. Rice	8.15 p.m.
12	Illuminating Engineering Society	P. S. Millar	8.15 p.m.
13	American Institute Electrical Engineers	R. W. Pope	8.15 p.m.
17	New York Telephone Society	T. H. Lawrence	8.15 p.m.
20	New York Railroad Club	H. D. Vought	8.15 p.m.
24, 25, 26	American Society of Heating and Ventilating Engineers	W. M. Mackay	All day
25	Municipal Engineers of New York	C. D. Pollock	8.15 p.m.

Date	Society	Secretary	Time
February			
1	Wireless Institute	S. L. Williams	8.00 p.m.
2	Blue Room Engineering Society	W. D. Sprague	8.15 p.m.
9	Illuminating Engineering Society	P. S. Millar	8.15 p.m.
10	American Institute Electrical Engineers	R. W. Pope	8.15 p.m.
14	American Society Mechanical Engineers	C. W. Rice	8.15 p.m.
17	New York Railroad Club	H. D. Vought	8.15 p.m.
21	New York Telephone Society	T. H. Lawrence	8.15 p.m.
22	Municipal Engineers of New York	C. D. Pollock	8.15 p.m.

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SPECIAL COMMITTEES
1910

On a Standard Tonnage Basis for Refrigeration

D. S. Jacobus — G. T. Voorhees
A. P. Trautwein — Philip De C. Ball
E. F. Miller

On Society History

John E. Sweet — H. H. Suplee
Chas. Wallace Hunt

On Constitution and By-Laws

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On Conservation of Natural Resources

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On Identification of Power House Piping

H. G. Stott, *Chairman* — H. P. Norton
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On International Standards for Pipe Threads

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On Standards for Involute Gears

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On Standardization of Flanges

A. M. Mattice — J. P. Sparrow
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On Student Branches

F. R. Hutton, Honorary Secretary

MEETINGS OF THE SOCIETY

THE COMMITTEE ON MEETINGS

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1910

On John Fritz Medal

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	1908			
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	1909			
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State Agri. College, Corvallis, Ore.	March 9	Thos. M. Gardner	C. L. Knopf	S. H. Graf
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University of Kansas, Lawrence, Kan.	March 9	P. F. Walker	C. E. Johnson	C. A. Swiggett
New York Univ., New York	November 9	C. E. Houghton	Harry Anderson	Andrew Hamilton
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Univ. of Wisconsin, Madison, Wis.	November 9	C. C. Thomas	A. MacArthur	A. Wegner
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Univ. of Nebraska, Lincoln. Neb.	December 7	C. R. Richards	W. J. Wholenberg	W. H. Burleigh
	1910			
Univ. of Maine, Orono, Me.	February 8	Arthur C. Jewett	A. H. Blaisdell	W. B. Emerson
Univ. of Arkansas, Fayetteville, Ark.	April 12	B. N. Wilson	C. B. Boles	W. Q. Williams
Yale University, New Haven, Conn	October 11	L. P. Breckenridge	Clayton DuBosque	W. Roy Manny
Rensselaer Poly. Inst., Troy, N. Y.	December 9	A. M. Greene, Jr.	A. M. Greene, Jr.	Harrison Weaver

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